TECH NAVIGATOR: BUILDING THE HUMAN-CENTRIC FUTURE

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The need for a human-centric future

The creation of an ideal society.

The impact of technology is universal. Machine intelligence has started challenging human intelligence in both good and bad ways. Before intelligent machines eclipse human intelligence, it is time to build technologies that behave the human way.

This report attempts to balance two perspectives. The first perspective is ideal: a digital world with human-machine symbiosis — good for the environment, society, and individuals. In this world, real-time, socially aware communication is beneficial; machines direct humans toward better health and prosperity; emotional human-machine interfaces alleviate stress; and virtual spaces enable pandemic-constrained populations to meet, innovate, and produce.

But the other perspective is practical and ultimately threatens humanity: technology removes our agency, transforms our actions into metrics, and makes us addicts to algorithms and prone to threats.

While the negative side of technology will always be there, the ideal version should take over for a better world, both in terms of monetary gain and stakeholder impact.

But how?

Human-centric intelligent systems are the mantra here.

This means that accountability for how data is used, algorithms are built, and systems are ultimately

together, where the unified goal is to make software and data more open and intelligible.

Obviously, society is now "beyond human." Many programs run in the background of an operation without any human involvement. Self-driving cars, automated credit approvals, robo-advisers, and algorithmic trading fall into this bucket. However, even with this level of "native" automation, humans should always be central to product development, monetization initiatives, and objectives for building these systems.

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> *Being human-centric means that empathy, accountability, and trust are the cornerstones of technological developments. If nudging people to buy a new health product or take out a life insurance policy is based on behavioral breadcrumbs we leave behind, then we who use these systems should be richly aware of what those breadcrumbs are.*
>
> **Nandan Nilekani**
> *Chairman, Infosys*
>
> "

In summary, as many firms think about their own practices and behaviors in developing technology systems, human centricity is an evergreen premise. The technologies will change, the level of human effort in using these systems may reduce, and the nature and style of human-machine symbiosis may force us to rethink how we carry out our jobs.

That said, if we, as practitioners and leaders, weave humility, emotional intelligence, and teamwork into everything we do, the future is good. Humans will then be free to define the course of technological development, all for the good of people, profit, and the planet.

designed falls to real people in visionary organizations. We should be able to trust that machines are working with and for us, symbiotically achieving good results in our professional and social lives. In this spirit, the need for a human-centric future built around technology is a call to action for all organizations, for all people.

This research lays out a path for how data and software can empower people. It illustrates how Infosys is tackling this problem. We cover the rise of artificial intelligence (AI) code generation and its ability to build these technology systems with more inclusive design principles woven in. And along with other cutting-edge developments, we tackle the subject of the metaverse — a paradigm where humans can collaborate and thrive
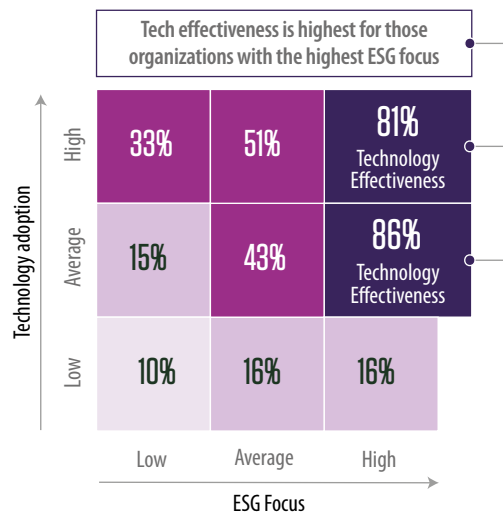
Human centricity increases profits

Towards better business outcomes.

Beyond doing good, human centricity increases profits. Digital Radar 2022, an analysis of technology adoption and effectiveness in big enterprises, found that firms achieve better results from their technology when they make humans the focus of their efforts (see Figure 1). In turn, this greater technology "effectiveness" is correlated with increased monetary reward[1] (see Figure 2).

ESG is a platform for a socially responsible future. It helps firms evaluate employee well-being and experience, and how well they consider customers and partners in their operating models. It also includes workforce profile, benefits, careers, productivity, well-being, and culture, along with ethical metrics related to immoral behavior and reskilling programs.

Satya Nadella's Microsoft has achieved some laudable ESG goals. During FY18-21, its profits and revenues marked a compound annual growth rate (CAGR) of 55% and 15%, respectively.[2] At Microsoft, employees believe the company is environmentally and socially responsible and delivers greater value for shareholders.

Figure 1. Technology adoption and an environmental, social, and governance (ESG) focus combine to deliver better technology outcomes

Tech effectiveness is highest for those organizations with the highest ESG focus

	Low	Average	High
High	33%	51%	81% Technology Effectiveness
Average	15%	43%	86% Technology Effectiveness
Low	10%	16%	16%

Technology adoption (vertical axis)

ESG Focus (horizontal axis)

Source: Digital Radar 2022, IKI

Our Agile Radar 2021 research found that business growth also accrues to those firms that make human-centric levers a core part of their operating model.[3] Firms instituting these human-centric levers at scale (known as "Sprinters") had better business and IT outcomes and were more likely to set long-term aspirational goals for their teams. Some industries, including health care, manufacturing, and high tech, do human centricity particularly well. They build solutions with the human front and center and are faster and more innovative.
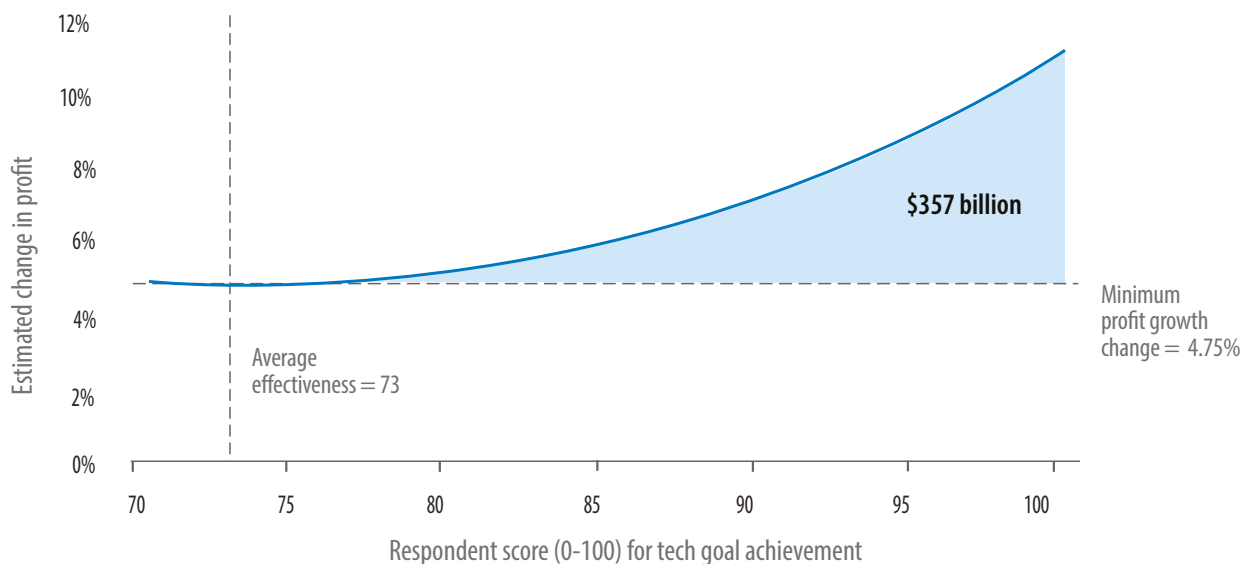
> *Our agile radar 2021 research found that human-centric levers such as upskilling, self-organizing, and using advanced collaboration platforms can increase business growth by as much as 63%.*
>
> **Alok Uniyal**
> *VP in Agile & DevOps, Infosys*

Figure 2. Improving tech effectiveness can boost profits by $357 billion

Source: Digital Radar 2022, IKI

The building blocks of a human-centric future

Empowerment, creativity, and human-machine symbiosis.

So how can your firm do the same? What technologies, processes, and ways should be adopted to outpace competitors and resolve the pain points of diverse stakeholders?

The Tech Navigator's first edition summarizes the need and approach for building a human-centric future. Our research includes interviews with technology experts, extensive literature reviews, and data from more than 5,000 companies. Here, the three building blocks are 1) human-centric design with purpose at its core, 2) hyperproductive, empowered humans, and 3) an enterprise metaverse to operate and thrive in (see Figure 3).

Theme 1:
Humans at the center of design and development:

This building block involves progressive, adaptive, and natural interfaces to technology systems. These "total experience" systems predict intent and satisfy diverse user profiles. They understand what humans are really looking for. They foster emotional connection and provide what-next recommendations by factoring in possible frustrations and fears of humans when communicating with technology. Data collected to optimize these user journeys can be safely guarded in the cloud, ensuring the data is private and only used for the intended purpose. These systems can also be built for diverse populations, removing biases and prejudices in the development stage. In this way, technology creates a continuously evolving, multivariate, live experience with humans at the core. This practice also ensures that technology is inherently "good," giving firms the ability to link value creation with ESG outcomes.

Theme 2:
Hyperproductive humans:

This building block involves the use of no code/low code (NC/LC) software to harness the whole creative capacity of the workforce. Everyone becomes a coder, and productivity skyrockets. A step further is where AI generates the code itself, given simple natural language prompts. This sort of human augmentation is now a $3 trillion industry. As humans increasingly find symbiosis with these AI systems, they can concentrate on higher-value work, letting the machines do the mundane labor. The future will be where AI is integrated into all business processes, forming a "live" enterprise — sentient, continuously evolving and learning, with humans

acting as stewards of the processes happening in the background. This "human in the loop" aspect ensures that systems don't perpetuate social inequities and reduces security vulnerabilities.

Theme 3:
The enterprise metaverse:

This building block provides a collaborative atmosphere for empowered humans to do their best work. Built on cloud, blockchain, and edge, the experiences humans have with computer systems will be even more perceptive, sentient, and present. This "third place" for enterprise collaboration will foster new business and operating models, with humans who have unique perspectives prized more and more.

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> *In the enterprise metaverse, humans have access to the whole system of systems. They can use data and software at will, often self-serviced, with frictionless sharing and collaboration beyond enterprise boundaries.*
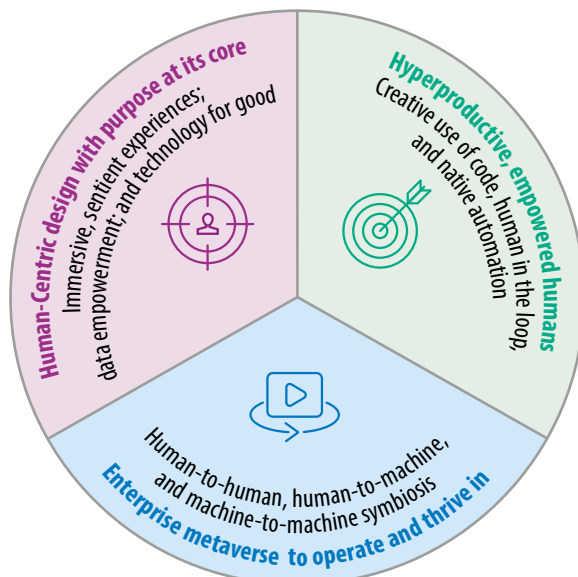>
> **Satish H. C.**
> *EVP – Co-Head, Delivery, Infosys*
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> "

In sum, this **human-centric future**, our metatheme, will create a trustworthy, transparent, resilient, and dynamic enterprise. This will harness the full potential of every asset in the organization. Great wealth creation will accrue to those who get on board this vision now, building a workforce that is more agile, creative, and curious. With humans at the center of both business and operating models, visionary firms should sell their services and capabilities as value-generating "human outcomes." They must also encourage risk-taking ability and remove bureaucracy. As the firm onboards AI, cloud, and other exponential technologies, the enterprise will become increasingly sentient and autonomous. It will also have humans right at the core of operations, increasing social credibility and profits.

Figure 3. The building blocks of a human-centric future

These three building blocks create an enterprise that

- Is more resilient, agile, sentient, and autonomous
- Is more human, with increased social credibility and profits

Source: Digital Radar 2022, IKI

Theme 1:
Humans at the center of technology design and development

From human-centric experience to technology for good.

Before building and developing human-centric solutions, firms should evaluate the following parameters:

Human-centric experience

Is the solution design compatible with human wants and needs?

Human empowerment

Does the solution reduce anxiety around safety, transparency, privacy, security, and sustainability?

Human effectiveness/sentience

Is the solution easy to use and predictive while delivering good human outcomes?

Human virtue

Is the solution low-cost and time-sensitive to humans while benefiting the demands of society and the planet?

Regardless of industry, region, or customer sentiment, these questions can be extended across a product's lifecycle (design, development, testing, deployment, maintenance, value realization, and modernization) (see Figure 4).

Figure 4. Practicing human-centric product creation

	Design	Development
Human-centric experience	Is the solution designed to delight the user by providing a seamless and inclusive experience?	Is there an active product owner involved who acts as the "voice of the customer"?
Human empowerment	How can we design the experience to empower people to fulfil their place in society and make better decisions?	Is the solution built with an emphasis on data privacy, explainability, and security?
Human effectiveness/ sentience	How can the solution be designed so that it's easy to use and sentient to each user's specific needs and behaviors?	Are sentient product features prioritized in the solution roadmap?
Human virtue	What design elements meet users' needs in terms of cost, time, and social good?	Are solutions developed in such a way that they meet stringent organizational ESG goals?

Source: Infosys

In Figure 4, the design and development stages are completely human-focused. The value realization stage is a good marker for how successful the **human-centric experience** is and how **empowered** humans feel when using the solution. This same technology should also be predictive of human needs (**sentient**) and act as a candidate to help firms meet ever-stringent ESG goals (**technology for good**).

By focusing on all areas of the framework, business leaders can pivot from a focus on shareholder primacy to an age where business works for a wider cast of actors, each of whom must be satisfied to ensure lasting corporate success.

Testing	Deployment	Maintenance	Value realization	Modernization
Is the experience solving users' problems or adding to their work?	Can the solution be fine-tuned in production based on new user insights?	Does the solution continue to meet users' experiential goals in production?	Do users adopt, and engage frequently with the solution?	How can the user become more enthusiastic about the solution?
Are users comfortable using the solution? If not, which elements are causing the discomfort?	Does the solution make good use of data and models in production?	Does the solution continue to meet ethical standards after deployment, and do teams have the requisite skills to make any changes to the solution?	Do users feel good about the solution?	How can the user become more empowered when using the solution?
How easy is the product to use? Were some features left out that should be included to meet design criteria?	Is the solution easy to use while scaling across multiple users?	Does the solution continue to work as originally intended?	Does the solution enable users to get things done more quickly and easily?	How can the solution become more effective for the user?
Is there a discrepancy between design and build in terms of how cheap, efficient, or humane the solution is?	Is the solution "good" even as it scales?	Is the solution cheap and efficient even when maintained for long durations?	Does the solution meet a firm's ESG goals?	How can the solution become cheaper and more efficient?

Case study

Pharmaceutical e-labeling application — the framework in action

Pharma companies usually use physical labels (mostly paper-based) for products. These labels, according to national requirements, should provide accurate information about drugs to patients and health care professionals. However, revisions to these approved labels take time to circulate, which is a potential risk to the patient's safety. Other constraints: 1) any updates on drugs have to wait until the next product release, 2) label removal is tedious in case of a product recall, 3) time to reach market can vary due to region-specific regulations, 4) labels involve high cost, and 5) labels have impaired readability due to cramped font size. All this is pushing the pharmaceutical industry to e-labeling. Let's understand the capability of e-labeling through a case study.

A pharmaceutical company wanted to build an e-label for a new brand of acetaminophen.

The **design** team realized that practitioners and patients wanted personalized information (medical history, etc.), something only an e-label mobile app can solve. Systems thinking suggested that patients wanted medicinal alerts. In the **development** phase, the team used natural language processing (NLP) to translate the labels into hundreds of languages and computational design schemas for a user-friendly experience. The development team worked closely with the design team to create a content management system to reduce cycle times and deliver faster label updates.

In the **testing** phase, the product owner discovered that users feared their data was being shared with health providers indiscriminately. A button was then added to the app to take a privacy-first approach. A note was also sent to the build team to introduce an exhaustive list of side effects for certain conditions, including a search function, to the next release. DevSecOps practices enabled a faster **deployment** of the app. It was further tested with a select few users before a wider rollout. Quick software updates with minimal impact on the end-user experience were challenging at this point.

Three months after the app launch, the **maintenance team** reported that the product worked as intended. However, a high net promoter score (NPS) disguised that some customers were reverting to paper labels.

Then, aggressive marketing campaigns were run to advise how to download the app and use the QR code, highlighting how most users are now less anxious about taking their medicines. During **value realization**, data analytics discovered that some doctors question whether the app's information is completely accurate and voiced concerns as to how the NLP system works.

Explainable AI (XAI) technology is touted for the next release, giving humans more insight into the output. Further **modernization**, enabled by a healthy dose to the R&D budget, could introduce natural language understanding (NLU) technology and semantics processes for better labeling accuracy.

Sub-theme 1:

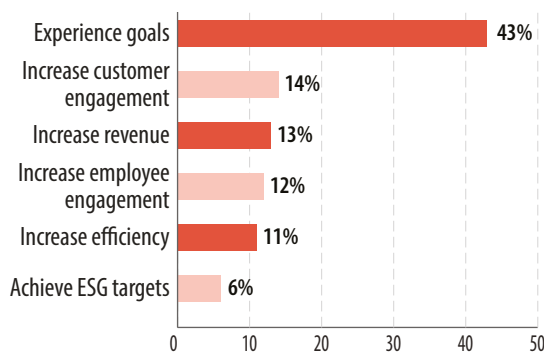# Human-centric experience

Contains:

- **Experience goals are the focus of big business**
- **The future of human-centric experience**
  - **Systems thinking**
  - **Gesture-based controls**
  - **Conversational intelligence**
  - **Immersive experience**
  - **Real-time human engagement**
  - **Sentiment analysis**
  - **AR/VR for equity and inclusion**

OpenAI can generate visuals of textbooks and use simple scripts to create photorealistic movies.[4] It can isolate unique characteristics of human speech and help robots master the art of touch. Systems will soon communicate with humans through facial movements and gestures. And then there's the extended reality (XR) paradigm being created by Facebook and Microsoft through a metaverse. On the enterprise side, there can be more real-time human engagements through chatbots, AI companions, and personalized web and app experiences.

Experience goals are the focus of big business

The concept of total experience (TX) — the unification of systems touching the employee, the customer, and the user/partner — will also become more meaningful going ahead. In our Digital Radar 2022 research, we surveyed 2,700 digital transformation leaders from the U.S., Europe, and Asia and found that experience goals are now the focus of big business, beyond just gaining efficiencies and generating revenues (see Figure 5).

Figure 5. Experience goals are now the focus of big business

Source: Digital Radar 2022, IKI

The future of human-centric experience

Further research[5] conducted in 2020 with Infosys practitioners and experts predicted that the next age of experience technology ("H3" in Infosys parlance) would use self-learning, adaptive, and natural interfaces for a hyperpersonalized, inclusive, immersive, and ambient experience (see Figure 6). And the numbers are proving that. Also, the XR market (combining augmented reality (AR), virtual reality (VR), and mixed reality) will grow exponentially. The XR market is set to grow from $26 billion in 2020 to $398 billion by 2026.[6]

So what do the key human experience patterns and characteristics in Figure 6 mean for big enterprises? What will enable more responsive, personalized, and enjoyable human-machine interactions?

> *Executives are looking to optimize business outcomes by focusing on overarching experience goals, beyond just efficiency and revenue generation.*
>
> **Ben Wiener**
> *Head of WONGDOODY*

Systems thinking

Firms will use systems thinking — a disciplined approach for examining problems completely and accurately before scaling a solution — to ensure experiences factor in the user's (whether employee, customer, or end user) wider social circle and all adjacent touchpoints. In this paradigm, design researchers will need to be more collaborative and embed as mentors with autonomous Agile teams. A data scientist skillset will be highly prized as data becomes the cornerstone of increasingly personalized, sentient experiences.

Figure 6. More immersive human experience

H3
Progressive, Natural, Interface, Adaptive
Hyperpersonalized, Immersive, Ambient

| KEY PATTERNS	CHARACTERISTICS
• System thinking	• Immersive
• Adaptive	• Natural user interface
• Natural experiences	• Gesture-based controls
• Progressive	• Smart speaker
• Lean UX	• 3D models
• In-place collaboration	• Animation

Source: Infosys TechCompass

A multinational educational startup wanted to bring a technology shift to the education system. It gained a deeper understanding through several use cases of multicultural students, parents, faculty, and staff. It successfully developed a flexible data platform that fulfills the personalized requirements of students, staff, and parents. Notably, the team could have conceived a much more restrictive application in the absence of sufficient use cases.[7]

Gesture-based controls

Humans increasingly want touch-free control of devices. This means machines need to understand speech, gestures, and even facial expressions. With gesturing, signals from hand movements serve as inputs to the system, and the deep learning algorithm can accurately anticipate what a human requires. For an easy-to-use and intuitive design, user interface (UI) experts must study different gestures at the micro level and ensure intergenerational differences are accounted for in the training data.

The XR market
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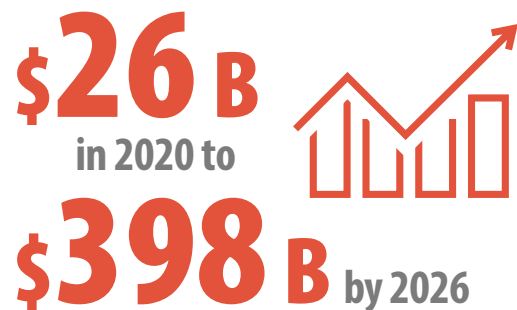
Conversational intelligence

Natural user interfaces need conversational intelligence (CI), using AI such as NLP and NLU. CI gives voice or text commands in natural language to systems. CI finds applications in many segments, including knowledge mining, customer service, cross-sell and upsell marketing, and transactions across digital channels. The CI market is poised to grow at a 31% CAGR over 2021-2028 to reach $46 billion.[8] The most advanced solutions, including those from Infosys Nia, IBM Watson, and Microsoft Cortana, throw away the critique that robots have no personality. These systems exhibit profound

knowledge of many subject areas (trained as they are on a wide corpus of data), and scripting errors are mitigated through continuous self-learning capabilities. CI systems will become even more immersive and personalized to provide an "immersive experience" going ahead.

Immersive experience

Immersive experiences bridge the gap between physical and digital worlds, leading to multimodal, multidimensional experiences. While much of the fanfare is for the XR experience in games (especially Roblox and Fortnite), it can also help in field engineering (a maintenance person can receive real-time instructions from experts globally) and in setting high-tech design meetings for employees.

Infosys' flagship sales leadership event, "Connect 2021," was conducted virtually on Infosys' EPOCH Platform. EPOCH is a state-of-the-art collaboration platform that helps conduct online events and supports immersive experiences. Connect 2021 was powered by 3D booths, a 360-degree immersive tour of Living Labs with over 20 showcases, and an immersive navigation console. EPOCH is powered by WebVR and XR technologies.

Real-time human engagement

Business content must be tailored to unique individuals to support rich experiences across the whole customer/employee journey. Therefore, personalization at scale requires a data platform layer that stitches together human/customer identities, collects omnichannel human behavior, and analyzes and acts on this information instantly. These real-time capabilities work on the premise of a customer genome, a fingerprint of customer behavior across all touchpoints, both now and in the past. Infosys Genome and Adobe Experience Platform are two such systems making this technology possible. The Infosys Genome solution powered a hyperpersonalized multichannel experience at a large sportswear manufacturer. Via precision marketing and innovative e-commerce campaigns, the system resulted in a 35% repeat buyer rate, a 67% improvement in NPS, and a customer reach of over 95 million.

Sentiment analysis

Sentiment analysis is a subset of NLP. Trained on vast language databases, these algorithms break down the text and score it for sentiment and emotion based on the words and phrases it contains.

The technology can be used to flag abusive or upsetting speech, steering conversations in real time toward positive human-to-human interactions. It can also flag and block content that draws minors into harmful social media rabbit holes. However, the technology should be used with caution. Especially in the case of mediating interactions, written communication can become more robotic and less carefree, detracting from the human element.

Infosys Text Analytics Platform offers a suite of API-based services, including semantic search, skill knowledge graph, sentiment or subjectivity analysis, rule extraction from legal documents, document classification or categorization, email or chat-based automation, log comparison, and automated data-labeling. The platform supports product hyperpersonalization by providing deeper insights to reduce churn and increase cross-selling.

AR/VR for equity and inclusion

AR/VR is entering the mainstream but still lagging somewhat in the enterprise. As devices and applications become more advanced, user-friendly, and more affordable, they will have a wide-reaching, transformative impact on work, learning, and communication. To ignite development, firms should consider a wider variety of user needs from the outset. Inclusive applications will give individuals more choice in portraying themselves in virtual environments and enable ecosystem participants to deploy the technology across a diverse user base. Flagging safety and security concerns in the early product and policy development lifecycle will also be helpful. Policymakers can mitigate regulatory uncertainty by clarifying how and when existing accessibility, anti-discrimination, and privacy laws apply to AR/VR solutions, while businesses should invest in R&D labs to spur equity and inclusion innovations. These immersive environments can deliver individualized experiences that meet users' unique accessibility, privacy, and safety needs. However, with all this talk of AR/VR doing good, there is one caveat; poor populations who can't afford the hefty price tag of AR/VR may actually be excluded, exacerbating poverty and cultural divides.

Sub-theme 2:

Data empowerment and protection

Contains:
- **Data users in control**
- **Data empowerment at enterprise scale**
  - **Confidential computing: Building data empowerment into technology systems**
  - **Federated learning**
- **Case study: Data spaces for telco data sovereignty and protection**
- **Data as a path toward prosperity**

Data users in control

Users should have control of what data they choose to share with a company. Transparency is also crucial. "All of us generate a lot of data in every transaction we carry out. And that data is collected by a few companies and then they monetize it. But that data is ours," says Nandan Nilekani, Infosys co-founder.[9] Satya Nadella, Microsoft's executive chair and CEO, also called for users to get more monetary value from their data at the Davos conference in 2020.[10]

Awareness around data empowerment, privacy, and monetization is at its peak, especially after big banks have been hacked and in the tailwinds of the Cambridge Analytica scandal. Books such as Shoshana Zuboff's "The Age of Surveillance Capitalism" underscore the need for big businesses to take data protection seriously. Data power asymmetries are growing, with users on one side and large technology companies on the other.[11]

General Data Protection Regulation (GDPR), enacted in 2018, requires that data should only be used for the purpose intended. And data should also be **portable**, and we will return to this in our third theme — the enterprise metaverse.

No industry sector received a
trust rating
of over 50%
in how they acquire and process data

Data empowerment at enterprise scale

Firms are increasingly measured by how well they enable users to have control of their data. Some are hoping to take a leaf out of Estonia's playbook. The small country has set up blockchain systems for data lineage, enacted legislation through the Personal Data Protection Act, and increased transparency for security breaches. Citizens can access, correct, and manage their data virtually, together.[12]

With increased vision comes increased challenges. Some firms are sitting on siloed data stored in numerous data lakes and warehouses. There is no standard process for data removal or transfer. Firms should implement deep data discovery with "clean rooms" so that data transfer between data repositories is pervasive, and user information is identifiable across structured and unstructured data.

Infosys Enterprise Data Privacy Suite (iEDPS) can help here. It ensures that data in production environments is only for legitimate needs such as application development and testing. It also ensures firms are regulatory compliant, and all personally identifiable information is protected.[13] A large U.S. bank used iEDPS to build a secure data exchange data protection service. This created a boundaryless organization for its partners, employees, and customers globally and improved its data sanitization productivity efforts by 40% across multiple data sources and more than 1,500 applications. A major health care provider in the U.S. used the solution to comply with the Health Insurance Portability and Accountability Act (HIPAA) and mask multiple consumer data sources and electronic data interchange (EDI) files. The solution not only reduced the total ownership cost by 40% but also significantly improved the time to market.

Confidential computing: Building data empowerment into technology systems

The Data Empowerment and Protection Architecture framework in India builds data empowerment and protection into the technology architecture. It introduces privacy and empowerment as the default case in processes and IT systems across the entire information lifecycle. With most of the Indian populace generating personal data histories for the first time, the framework aligns policy, regulation, institutions, and technology architecture — balancing the rights of the individual with those of the state.

But it can't prevent rogue organizations from using and processing data in a way not originally imagined by the populace. To become an end-to-end data empowerment and protection vehicle, "use limitation" will need to be encoded into the technology. For this, advances in confidential computing are crucial. Companies like Microsoft and Google are using confidential computing in their clouds to ensure data is safe and never leaves the execution environment. This provides real humans with guarantees that their data is being used only for the intended purpose. Firms can deposit data in these safe environments; in so doing, they empower users, comply with stringent regulations, and ensure that their user's data is not open to phishing and malware.

Federated learning

Another privacy-enhancing technique is federated learning (FL). This is a machine learning (ML) capability to train models across multiple decentralized servers without centralizing training data. With the growing regulation around third-party cookies, browsers like Brave are using FL to authorize ad targeting only by user "opt in." In return, users are rewarded with cryptocurrency. The Brave browser can achieve an ad hit ratio of up to 70% while achieving almost perfect privacy preservation.[14] Another technique is federated learning of cohorts (FLoC). Google began using this in Chrome in the middle of 2021. Put simply, FLoC eliminates the need to provide personal data to third-party advertisers by grouping users into cohorts with similar browsing histories without ever centralizing these histories in the cloud. Google clients then only access data about these cohorts, not individual users, increasing user data empowerment. The solution is almost 95% as effective as cookie-based advertising, though some companies are blocking the technology, as it still shares cohort information by default. A testing sign of the ambivalence of Google's approach is that they're not testing FLoC in the EU and the U.K. for fear it might be illegal.[15] One argument against the method is that it may actually exacerbate many of the worst non-privacy problems with behavioral ads, including discrimination and predatory targeting.

Case study

Data spaces for telco data sovereignty and protection

Communication service providers (CSPs) need automated mechanisms for trusted, dynamic, and transparent data sharing. Infosys, with its expertise in certified data infrastructure, has worked with companies such as Orange, Vodafone, and Ikanotis Partners to create a proof-of-concept Telco Data Space, borrowing from the work of the Gaia-X European project. Gaia-X capabilities and requirements include:

- Sovereign secure exchange and processing of data in a trusted, decentralized telco ecosystem
- Data usage guidelines for each CSP
- Data governance and data control
- Certified applications to collect, manage, and process data within a trusted distributed environment.

In the Telco Data Space, all participants can share and process data using a special federated connector among different clouds, ensuring that protection and sovereignty of data are in place. There is also a way of identifying commercially sensitive data, flows, and usage restrictions to ensure trust is installed in the business and technology layers.

The data space will enable CSPs to form new business opportunities with partners and provide services to customers in multiple markets. Data can be aggregated from different players so that CSPs can offer value-added services to their customers, including roaming and profile/context information from both domestic and external networks. This all works to increase customer experience while increasing cross-data analytics among firms, dynamic end-to-end service assurance, cost reduction, and greater efficiencies through native automation. Further, the solution enables CSPs with multiple factories in different countries to offer multisite services and capabilities.

Data as a path toward prosperity

Companies from Brave to Apple, who are themselves making strides with AI-based privacy-on-device, have realized that personal data can be a force for good when used appropriately. Innovations such as the e-labeling app (discussed earlier) are only possible when personal data is shared discriminately, with privacy and security safeguards. And data can also be a path toward prosperity. With the right technology infrastructure, along with policies that accelerate human and societal development, people can buy, share, and trade their data in a common marketplace. For this, a new ecosystem will have to evolve, with easily accessible and usable data management tools at the disposal of people globally.

This is the vision of the enterprise metaverse, explored in the last theme of this report.
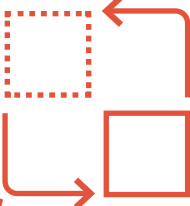
Sub-theme 3:

Sentient experiences

Contains:

- **The business need for sentient systems**
- **How sentient experiences work**
- **Key sentient principles**
- **Sentience as scaled empathy**
- **Use case: Toward sentience — The Infosys Customer Intelligence Platform**

67% of customers switch brands

due to a lack of personalized engagement, U.S. Chamber of Commerce research found

The business need for sentient systems

According to the U.S. Chamber of Commerce, 67% of customers switch brands, not for improved product features or lower price, but due to a lack of personalized engagement.[16] Personalization cannot be an afterthought,

and the very best systems should use inference for a seamless user journey. With proper safeguards, AI systems should seek to understand the users' emotional state and contextualize the experience to make it useful for human requirements at any given time.

> *As we build more personalized and perceptive experiences, it's important to implement privacy and security by design upfront, to earn the trust of human and system users.*
>
> **Rafee Tarafdar**
> *CTO, Infosys*

How sentient experiences work

Sentience goes beyond the classic personalization story, a paradigm once characterized by applying simple business rules to optimize the relevance of various system parameters. In this older landscape, personalization was based on simple, explicitly expressed user preferences, such as more Kindle recommendations on Amazon or action movies on Netflix. However, the experience itself predominantly stayed static, with each user generally seeing the same thing. Instead, sentience goes a step further, applying AI to emotionally engage and delight very specific and unique individuals.

How do sentient experiences really work, then? True sentience is created by a "digital brain" that combines

Figure 7. How systems become sentient
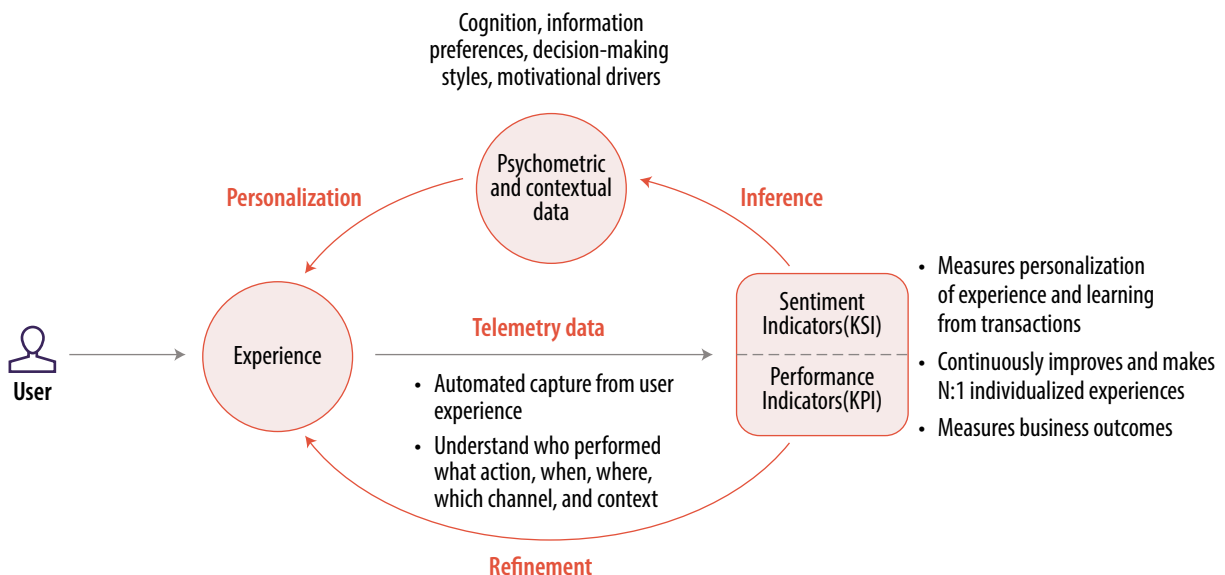
Source: The Live Enterprise: Create a Continuously Evolving and Learning Organization

each person's behavioral data into an experiential map, at the individual level. This is done over long periods of time. The behavioral data is combined with other data sources, and various permutations of the experience are simulated. The overall system learns how real humans react to the experience, which is continuously optimizing (see Figure 7). This enables each person's experience to be unique, and via Key Sentience Indicators (KSIs), a business can measure the software aspect of the person's engagement, including motivational and psychometric drivers, decision making style, and cognitive preferences.

As underlying processes are redesigned with human aspirations in mind, telemetry, or the current data state of the system, can be captured across all interactions and be used to continuously improve the underlying experience through prediction and refinement.

Imagine a sentient experience that learns from a person's engagement with it, recognizes that they use the experience differently than others, and optimizes it for their specific workflow. It also realizes that they're not engaging with it as regularly as expected, and sends them nudges designed to motivate, gently gamifying the overall experience. Over time, the sentient experience tries out different ways to display data, from textual, to visual, to diagrammatic — and learns how the user engages best with the information to take an action.

We believe this is the next level of human experiences, powered by sentience and data. In this way, advanced technology is making human experiences more personal and emotionally engaging.

> *Sentient experiences are not just personalised, but emotionally engage based on each person's specific motivational drivers, decision making style, and cognition preferences. We believe this is the next level of human experience. In a way, you could say that technology makes our human experiences more personal and emotionally engaging.*
>
> **Ralf Gehrig**
> *Chief Experience Officer, WONGDOODY*

Key sentient principles

Any such system would need to learn and evolve in real time to be truly user-friendly and personalized. Infosys has used the below five sentient principles for its journey toward a live enterprise.

1. **Proximity to the source:** Provide all information to users at the time of decision-making.
2. **Zero latency:** Enable human needs to be met without multiple steps and approvals. This is known as "straight-through processing."
3. **Instant simulation:** Enable users to evaluate alternatives at the point of decision-making. What-if scenarios are run by the system to predict potential failure.
4. **Micro feedback:** Recommend routine decisions and actions to users and enable users to give feedback. This enables the system to learn friction points, which can be used to optimize the ease of moving through the customer journey.
5. **Guided practice:** Provide the user a well-defined pathway to complete a specific activity, which is essential to drive human behavioral change. Users then learn how to use the system in the process.

Sentience as scaled empathy

Firms should create digital experiences that are not just efficient and easy to use, but that connect and engage people on an emotional level. In customer-facing experiences, e-commerce, and digital marketing, this is already the case. But are these experiences really sentient and do they really connect as strongly as they could? And what about employee and partner-facing experiences? Here, there is a huge opportunity for sentient experiences, given the amount of time employees spend at their workstations. Any incremental improvement in employee experience can have a huge effect on motivation levels and overall happiness. Finding the right visualization that fits an individual's cognition style will have a huge impact on the organization. In this sense, creating empathy through sentience is the next frontier in human experience design, a practice spearheaded by WONGDOODY. In this paradigm, firms are led on their journey towards a truly evolving and empathic live enterprise, directed by a designer but amplified through technology.

Use case

Toward sentience — The Infosys Customer Intelligence Platform

Regardless of industry, a **sentient customer experience** can provide significant brand impact.

In insurance, for example, an ecosystem of partners works together to provide information on investments, mortgages, and auto insurance products. The customer journey must be one step ahead and align all stakeholders at every touchpoint. Any effort at establishing sentient customer experiences must factor in consistency of service and omnichannel capabilities. Automated personalization across mundane touchpoints, reminders, recommendations, recurring events, and pattern recognition is expected. Data vulnerabilities and privacy intrusion must be factored into the design.

The Infosys Customer Intelligence Platform takes these factors into account. Based on Infosys

AI intellectual property, the platform provides "hypercontextual" sentience, anticipating human needs and acting on them with real-time recommendations. Based on historical interactions, events, and other data, it can sense, respond to, and automate routine business decisions.

The system comprises three main functions (see Figure 8).

The platform also builds psychographic profiles of customers based on activities, opinions, and lifestyle choices. The platform can also identify emotional responses; motivations; moral, ethical, and political values; and the inherent attitudes, biases, and prejudices that sometimes drive consumer behavior. Here, the system uses the intelligence layer to provide just-in-time interactions. For instance, with native automation (discussed in Theme 2), a fully automated store could use the system for inventory tracking and with chatbots that converse engagingly with busy individuals.

Figure 8. Three-way sentient customer experience

Modernize
- Senses signals in real time: Gathers "phygital" (physical + digital) data during the event.
- Unified semantics: Accesses and senses data from core systems through unified semantics and ontology.
- Co-relate and mind map: Identifies hypercontextual physical and digital data about an event, such as an accident or emergency request.

Intelligence
- Digital brain: Combines data, algorithms, and learning to drive intuitive decisions.
- Knowledge graph: Builds a graph database to map the many-to-many relationships between the entity and other entities. Entities include the user, business, and product
- AI services: Analyzes data, images, documents, and unstructured information through microbots, influencing decisions.

Experience orchestration
- Sentient experience configurator: Anticipates and surfaces the most needed feature based on real-time customer needs
- Personalized campaigns and nudges: Creates mobile, web, email subject, email content, social media, offers, conversation, and video.
- Automates business processes: This enables adaptive supply chains, promotions, and channel monetization.

Source: Infosys

Sub-theme 4:

Technology for good

Contains:
- **"Good" technology impacts the bottom line**
- **What does "good" technology look like?**
  - **Quantifying pain using data-driven tools**
  - **Crowdsourced low-power Wi-Fi for energy-efficient networks**
  - **Discovering new antibiotics using AI**
  - **Speedier recovery from natural disasters using computer vision**

"Good" technology impacts the bottom line

Humanizing the design and development of technology boosts profits, as Digital Radar 2022 proves. But what about society as a whole? How can technology be used to thwart some of the biggest ongoing social (and health) issues?

Many new startups and enterprise research divisions have increased their beneficent R&D budget in recent years. Amazon spent more on doing good in 2020 than many large EU countries, with an increase of 19% in R&D year-on-year.[17] This sort of work has a tangible impact on the bottom line. The top 500 global asset managers place a premium on the "sustainability nexus" that links purpose, diversity, equity, inclusion, and ESG principles.[18]

What does "good" technology look like?

From better ways to produce indigo for jean coloring to synthetic data generation for reduced human labor to measuring bias for more inclusive health research outcomes, technology is increasingly making planet Earth a better place. Below are a few such examples:

Quantifying pain using data-driven tools

Each year, chronic pain costs $560 billion in the U.S. alone, which comprises health care costs and lost productivity.[19] But the accuracy of data is debatable. A data-driven, patient-centric approach is needed. Bringing together neuroscience and AI, researchers are analyzing data from at-home assessments to calculate long-term pain dynamics and predict the treatment that will lead to pain relief. This technique calculates discrepancies among self-reported pain measures and predicts and quantifies placebo responses. "In this way, pain management becomes more accessible, personalized, and trusted, for patients across diverse socioeconomic backgrounds," says Sara Berger of IBM Research.[20] Further measures are underway to ensure fair and unbiased pain treatments.

## Crowdsourced low-power Wi-Fi for energy-efficient networks

Bringing together the Internet of Things (IoT), AI, and blockchain is bearing fruit. Helium, a decentralized network, has made internet access possible in far-flung regions globally. This network operates on a low-power, long-range, unlicensed sub-gigahertz spectrum and uses a novel algorithm that rewards users for verifying coverage. Users buy a router and set it up in their home, forming one node on the network. They can then earn over $20 a day in cryptocurrency tokens. In the future, billions of IoT devices will be connected on this blockchain in an energy-efficient manner, reducing the need for 5G antennas and fiber optic cables. A counter argument to the technology is that it sucks unsavvy people into the crypto ecosystem while allowing Helium itself to avoid paying "real" money in return for users becoming a node on the network. As some experts say, twenty dollars a day in essentially valueless tokens that are difficult to trade might not be a good thing.

Discovering new antibiotics using AI

According to the World Health Organization, resistance to antibiotics is one of the greatest threats to humanity.[21] Michigan University's drug discovery lab is building models to develop personalized therapies that work in synergy with a person's immune system and reduce resistance to antibiotics. These novel drugs reduce the chance of developing drug resistance, have enhanced potency, target different pathogen populations, and can be used for repurposing existing drugs into novel treatments. A hybrid approach, combining cutting-edge deep learning and traditional engineering, is created to tackle the development of fatal diseases. For instance, one key disease that kills 1.3 million people annually is tuberculosis. The Michigan team has identified an antimalarial drug using ML, which can be repurposed for treating the disease while reducing treatment times.

Speedier recovery from natural disasters using computer vision

Climate change is increasing the severity of natural disasters. In 2020, $190 billion of damage was inflicted on homes, more than four times the amount in 1990. Further, the global population exposed to natural disasters will increase eight times in the next 60 years. A new AI-augmented system from the firm Tractable allows homeowners to take photos of their homes after a natural disaster (e.g., hurricanes) to predict repair costs and unlock insurance claim payouts months faster.[22] A leading Japanese insurer is already using this solution. The technology can help thousands of households recover from the effects of Typhoon Mindulle (projected to have inflicted $100 million in damage to 20,000 households). It can also accelerate recovery from floods and hailstorms and identify homes exposed to fire risk from nearby vegetation.
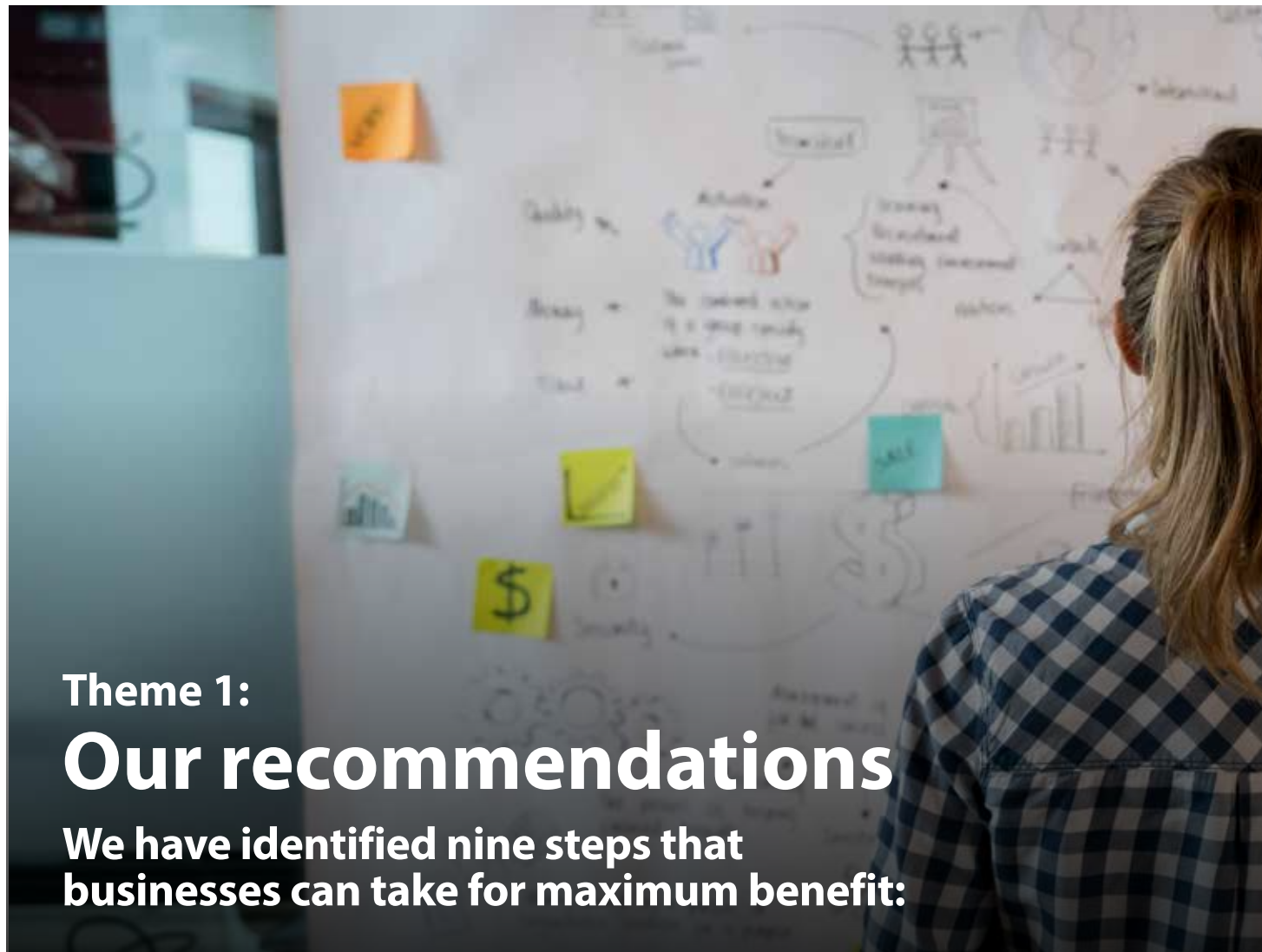
Theme 1:
Our recommendations
We have identified nine steps that businesses can take for maximum benefit:

Strategic recommendations

- **Focus on human needs that align with a strategic vision:** Based on the business's strategic direction, leaders need to understand both employees and customers, and use systems thinking to solve their major pain points.

- **Understand your key use cases:** To ensure experiences are human-centric, leaders must understand the key uses cases and carry out focused research to understand those that are relevant to their business and return on investment.

- **Invest in security for life-critical systems:** Complex digital systems are vulnerable to cyberwarfare. Firms need to safeguard the reliability and safety of all software systems, particularly those posing direct life threats (such as medical devices and aerospace products).

- **Use external platforms in a tailored manner to drive enterprise sentience:** To get a head start on implementing sentience, firms can adopt platforms such as the Infosys Live Enterprise Suite. This offers tailored experiences, including Infosys Launchpad (to onboard new employees); InfyMe (for employee personal productivity, work productivity, and insights); and Lex (for educational and career development).

- **Be guided by the U.N.'s sustainable development goals:** The U.N. has laid out 17 goals in their 2030 Agenda, including thematic issues, such as water, energy, climate, oceans, urbanization, transport, science, and technology. Firms that commit to the goals will see a marked improvement in business excellence, along with a tangible impact on the bottom line.

Tactical recommendations

- **Onboard creative designers with business insights:** Technology designers must be excellent storytellers with the ability to influence executives. They must address what is most important to human-centric development while keeping in mind strategic vision.

- **Follow inclusive design principles:** Following Microsoft and Apple, leaders must be guided by inclusive design principles for the 15% of people with some form of disability. The best firms are mindful of accessibility and will build on those principles for AR and VR to deliver the best experience.

- **Invert the design approach for even more inclusivity:** Rather than considering the under-represented as an afterthought, consider turning the standard approach on its head and start by focusing on underrepresented and vulnerable user groups before adapting the solution to fit a wider audience.

- **Use composable technologies for better results:** Overhauling the entire application landscape will set the business back in terms of cost and time. For symbiotic human-machine interfaces, micro frontends can be used. These are bite-size pieces of monolith applications and promise a future where developers can refactor existing web application packages with proven JavaScript frameworks, such as Angular and React.

Theme 2:

Hyperproductive humans

## Unleashing the full creativity of the workforce.

Human-machine symbiosis is important. But it could be costly. And the skills needed to do the work aren't sufficient yet. According to some estimates, the U.S. alone will lose $162 billion due to the shortage of software talent, with the shortfall in the analytics space twice as dire as in product or service design.[23] Further, by only employing incumbent software coders to do the hard work, firms are giving away the opportunity to harness the creative capability of the entire workforce.

More software is essential for the 21st-century operating model. In our Agile Radar research, we found that firms with a strong software pipeline and a customer-centric approach have better business outcomes.[24] Further AI research of close to 700 companies at various stages found that making software easier to use has the indirect effect of bringing business and IT closer together. In this study, the visionary AI firms could share data science knowledge more rigorously than others and proved in-house competency to deliver AI technologies at scale[25] (see Figure 9).

This theme looks at a firm's hypothetical journey from democratizing its software knowledge (termed no code/ low code, or **NC/LC**) to augmenting workers using **AI-driven coding and writing** (as long as there's a **human in the loop**) to an organization that automates its core processes from the inside out **(native automation)**.

At each stage, humans become even more productive and focused. While full automation of business processes

Figure 9. Nine-tenths of AI visionaries have developed in-house competency, whereas seven-tenths of the rest depend on external support
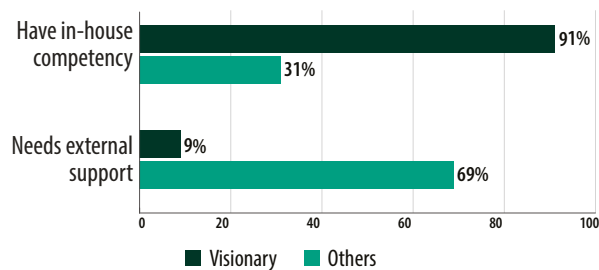
Source: Infosys

often inspires fears of job loss, many studies are on the reverse side. Automation can create more jobs than it takes away and enable knowledge workers to be more self-sufficient in their professional and personal lives.[26] For instance, instead of garbage collectors filling trucks, they can get involved with managing a fleet of robots — enabling them to use critical thinking skills that might have lain dormant otherwise. Detractors of this one-to-one mapping will say that blue collar worker can't easily take on knowledge-work, nor do they want to. This is a theme that becoming highly charged in newspapers across the world, and only time will tell which side is right.

Gartner predicts that NC/LC **will account for** **65%** of all app development by 2024

Sub-theme 1:

NC/LC

Contains:
- **NC/LC utilizes the whole workforce**
- **Benefits of the NC/LC paradigm**
- **The need for effective governance**
- **Use case: Democratizing design with NC**

NC/LC utilizes the whole workforce

NC/LC technologies require little to no coding knowledge to build applications and processes. This enables firms to overcome the shortage of talent in this area while empowering "citizen coders" to utilize their collective imagination on a working product.

Through NC/LC, executives build a strong software pipeline and democratize the firm's IP. This way, they can make their business more innovative, resilient, and data driven. According to Gartner, NC/LC applications will account for 65% of all app development by 2024. And Forrester perceives the LC market alone to be worth $21 billion by the end of 2022.[27]
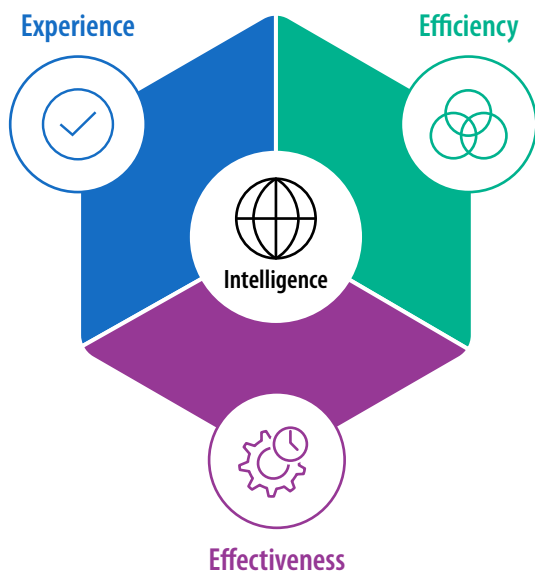
Shopify (worth $180 billion in 2021) has empowered layman developers to build and scale an e-commerce company at will. Tableau (a Salesforce acquisition)

enables product owners to understand and visualize data. For smaller companies, tools like FreshDesk empower accounting departments, and Canva (now worth over $3 billion) enables individuals to design and publish visual content, leveling the playing field for high-quality design.

With everyone involved in the coding process, LC alone can cut 90% of development time for web apps.[28] It is often as simple as point-and-click or pull-down menus. Business professionals can build departmental systems in a few hours. And with a bit of robotic process automation (RPA) in the mix, users can design automated workflows that touch on multiple systems. By using special connectors and application programming interfaces (APIs), databases connect to AI tools for further innovation.

Other NC/LC use cases include function-specific tools for marketing, virtual assistants, modernization of legacy systems to achieve agility, and LC case management systems. With analytics growing in importance, something we touched on in the Digital Radar report, NC/LC versions of predictive analytics are now possible that take the data scientist through an automated ML process.[29] Microsoft's Power Platform is a suite of NC/LC software for the enterprise. Programs run as web apps and democratize coding across data visualization, workflow automation, and analytics. Some LC platforms such as Sketch2Code and Yeoman also create evocative omnichannel experiences.

Benefits of the NC/LC paradigm

There is less need to onboard coding superstars, and complex software can be built quickly, within three to 12 weeks. Data scientists can work on higher-value projects that need acute data knowledge, and the rest of the organization has a chance of working with new tools, developing careers in the process. Other benefits include:

- Simplified security and compliance adherence
- Migration and elimination of existing shadow IT applications
- Easy minimum viable product and prototype development

Figure 10. A framework for NC/LC implementation

Source: Infosys

INTELLIGENCE

Unleash the power of AI-simplified data science and ML for predictive decisions and reusable cognitive services of NL vision, etc.

Amazon SageMaker, Azure MLstudio, Google autoML, H2O Driveless AI

EXPERIENCE

Design platform powering the best in class user experiences. Leverage power of the cloud to build, host, deploy rapidly mobile and web applications

Invison, Adobe XD, Sketch, Figma Outsystems, Axure, Powerplatform

EFFICIENCY

Model, automate, and optimize complex end-to-end processes with robotics, business process management, case management, process mining with cloud-first mindset

Pega, Appian, Bizagi, Celonis, IJP path, Automation, Anywhere

EFFECTIVENESS

Effectiveness of employees and teams by connecting enterprise data and people for dramatically increasing productivity.

Microsoft power platforms, G-Suite, AppSheet, Amazon Honeycode

- Ability to build niche use cases built on top of the existing enterprise resource planning (ERP) systems to avoid customization of the underlying system

For firms to get a handle on horizontal and industry use cases of NC/LC, a good start is to think about the problem space in terms of "experience," "efficiency," "effectiveness," and "intelligence" (see Figure 10).

The need for effective governance

Of course, there are risks involved. Some of these NC/LC tools have limited flexibility and use proprietary technology with partial portability. They also touch mission-critical systems. This is why building systems with human principles are even more important. And domain product owners are needed to scale, integrate, maintain, and govern these new systems — which comes at some expense. Additional security and privacy controls will also have to be configured and implemented to ensure data loss prevention, regulatory compliance, and controlled access and visibility to data and associated environments.

With an effective NC/LC playbook, business leaders can ensure their teams are using the technology appropriately. This means having the right policies in place, along with guidelines around which applications are allowed to be built on a platform and by whom. It also means designating a central authority to own the

approval process. Also, the whole enterprise should know which business processes can be automated using these tools and where manual, or human in the loop, exceptions are necessary.

As NC/LC proliferates (and to some extent AI-generated code does also), large enterprise vendors must keep an eye on disruptive upstarts taking them unawares. The NC/LC software platform upBoard is currently building a marketplace of instantly customizable business process apps.[30] SAP and Oracle in the enterprise space will need to continue simplifying their solutions for greater customization too. SAP Fiori, Salesforce Lightning, and Microsoft Dynamics are good examples of business platform add-ons. Such add-ons help customize enterprise applications, extend application functionality, and provide mobility extension on business platforms.

> "
>
> *Effective governance, operations, and monitoring can ensure NC/LC scales, and that adoption and consolidation are done in a structured way to democratize application development by citizen developers.*
>
> **Viral Thakkar**
> *AVP and Senior Principal Technology Architect, Infosys*
> "

Use case

Democratizing design with NC

Even as Adobe grows ever more confident and lucrative under the watchful eye of swashbuckling CEO Shantanu Narayen[31], nimble design tools from the likes of Canva are making strides. Canva is a multimedia design platform that allows users to create visual content via a mobile app or web browser. These NC tools emphasize ease of use and address a market where price point and user functionality are becoming ever more important. Teams are increasingly adopting these tools to produce graphics much faster.

NC tools remove development bottlenecks, which gives designers more control over the look and feel of the experiences they create. In Agile teams, developers focus on logic (often using LC tools themselves), and designers concentrate on style. The real magic is that tools like Canva and Adobe

XD integrate all the underlying layers of software into end products, "providing functionality through modular components that can be harnessed through intuitive visual interfaces," according to design author Jeremy Q. Ho.[32]

The near future of NC experience design will include:

- Omnichannel design for voice, mobile, and web, all in an integrated manner.

- AI services built on experience design platforms to automate design for UI artifacts, including icons, backgrounds, logos, and branding aspects.

- Rules-based and AI services to automatically translate designs into production code that can be directly used by development teams.

- ML-based code generators to create design and code from drawings and designs. Tools like Sketch2Code and Screenshot-to-Code and code generators like Jhipster and Yeoman are at the forefront.

Sub-theme 2:

AI-driven coding and writing

Contains:

- **AI augmentation delivers significant business value**
- **Using natural language to code**
- **Making coders, designers, and ML scientists more productive**

AI augmentation created $2.9 trillion

of business value in 2021, surpassing all other AI initiatives

AI augmentation delivers significant business value

Netflix now deploys new code 4,000 times every day.[33] To keep up with this pace, other firms are turning to AI-driven coding technologies. Innovators like Google, OpenAI, and Microsoft are letting their machines do the hard labor. This means that AI systems autocomplete segments of code, fine-tune algorithms, search source code, and find troublesome bugs.[34] Analysts say that this sort of AI augmentation created $2.9 trillion of business value in 2021 alone, surpassing other AI initiatives.[35]

Using natural language to code

These systems can even use natural language prompts and write code from scratch. This is what OpenAI's Codex software does. Trained on OpenAI's GPT-3 natural language model (and billions of lines of source code retrieved from public sources, including GitHub), the system can translate natural language into 12 different computer languages. And it can even translate among them. After breaking down a problem into manageable smaller problems, a developer can call Codex to map these problems to existing code (libraries, APIs, or functions) automatically. Joel Hellermark of Sana Labs, a Swedish startup, is creating dynamic coding courses

using Codex. The courses start by applying natural language to coding but then train students to craft more of their own, more efficient code over time.[36]

SourceAI, a Paris startup, is also doing work in this area. In their model, a short test description of what the program should do is all that's needed. Given simple commands such as "add apples and oranges in my Excel spreadsheet," students will now be able to "do their homework quickly," says CEO Furkan Bektes.[37]

Making coders, designers, and ML scientists more productive

According to Brendan Dolan-Gavitt, a professor of computer science at New York University, other products will be built that "make software programmers even more productive by identifying likely bugs in the code as they're being written, and by looking for 'surprising' code in completed scripts."[38] Facebook published details of Aroma in 2019. This AutoML tool identifies functionally similar lines of code, enabling programmers to write scripts more quickly and identify subtle bugs in a language such as Python or C++. Microsoft, for their part, has their GPT-3 PowerApps natural language software — which is, as of the time of writing, mainly used for complex data queries to underlying databases.[39]

There are also programs that generate images based on a wide array of natural language prompts. DALL-E, from OpenAI, treats text-image pairs as a generative task and learns to generate believable images from a wide array of prompts. DALL-E is a 12 billion-parameter version of GPT-3 and receives encoded images and texts in the form of a sequence of 1,280 tokens, which it models autoregressively. The best image samples are ranked using a technology called Contrastive Language-Image Pre-training (CLIP) — a neural net with zero shot capabilities — to consistently yield impressive visualizations. A natural question that arises here is, "What is the right prompt to use?"[40] Indeed, the exact framing of the text prompt has a large effect on the quality of the results.

As a popular Wired article by Tom Simonite explored, ML can even be used to generate better ML. The paper famously quipped, "About three years ago, some Google researchers paid handsomely to invent new AI software invented AI software to do some of their work. Their metalevel AI was soon better at some parts of their job than they were."[41]

It's not untoward to imagine that Microsoft might integrate an AI natural language code feature into Excel, reaching hundreds of millions of users and vividly expanding access to enterprise users.

Sub-theme 3:
Humans in the loop

Contains:
- **The problem with bias, malware, and Tay Risk**
- **The AI Act in Europe: A sign where things are headed**

The problem with bias, malware, and Tay Risk

"Codex can generate code with structure that reflects stereotypes about gender, race, emotion, and class," OpenAI researchers warned in a paper released in July 2021.[42]

Measuring bias is, therefore, an important first step toward more inclusive research outcomes. In health data, the problem is fierce. ML solutions trained on data with missing information and biases in demographic information are widespread, and solutions need to adapt for these biases to avoid perpetuating health and social inequities. Also, by replicating buggy software, these new tools might inject security vulnerabilities into systems, and the software itself might be used to empower phishing attacks or introduce malware that remains undetected. AI is also vulnerable to Tay Risk — meaning that it can often offend people. These dangers all require supervision.

"Human oversight and vigilance are required for safe use of code generation systems," the OpenAI paper concludes. Shashank Srikant, a Ph.D. student at MIT, concurs. Some AI models shouldn't be relied on too much at present. "Once these models go into production, things can get nasty pretty quickly."[43] For instance, he says that AI language models are notoriously capricious. Words and phrases are often mixed up, with some sentences contradicting themselves. The irony is that it often requires deep coding experience to check the output of AI coding programs.

Further, AI tends to replicate unconscious human biases. It's then not just a case of examining the assumptions the AI and ML are working on, but also including diverse humans in this effort. Bias-free AI is impossible, however good the intentions, especially when much of it is strategized, built, and overseen by largely college-educated Westerners. With oversight by more typically marginalized workers, firms will have more reason to be transparent in their creation of code, overcoming the tension many have in disclosing what for many is reputationally-sensitive IP. Organizations that are prepared to be transparent will be the ones that will do better in the future, as they are the ones that will be trusted to do what's right for the world at large.

The AI Act in Europe: A sign where things are headed

Regulation can also help in this regard. The AI Act in Europe[44], introduced in April 2021, ensures that "high-risk" AI systems, including code generation algorithms that touch on industries like health, finance, and defense, are subject to more scrutiny and accountability. Outputs of systems need to have human oversight, and be built so that intervention, judgement, and review is possible. According to a draft of the report shared at the Nordic Conference in late 2021, AI itself can be used to narrow down a set of contentious content for human vetting, "who then may need to assess the illegal nature of such content" and weigh in on areas where "error rates are high or where contextualization is necessary."[45]

Get this part right, and we're headed to what some experts call Software 2.0. In this brave new world, the focus will be less on teaching humans how to understand computers, and, in the words of Microsoft CTO Kevin Scott, more on teaching "computers how to accomplish a task in terms that are convenient for a human."

> *Outputs of AI systems need to be interpretable, secure, and must contain all necessary technical documentation for effective use, while registering logs of their behavior. Even more, they must have effective human oversight.*
>
> **Rajeshwari Ganesan**
> *AVP, Infosys*

Sub-theme 4:

Native automation

Contains:

- **Embedding AI into operations**
- **Implementing native automation with the focus on customer experience**
- **Human in the loop for exception handling**
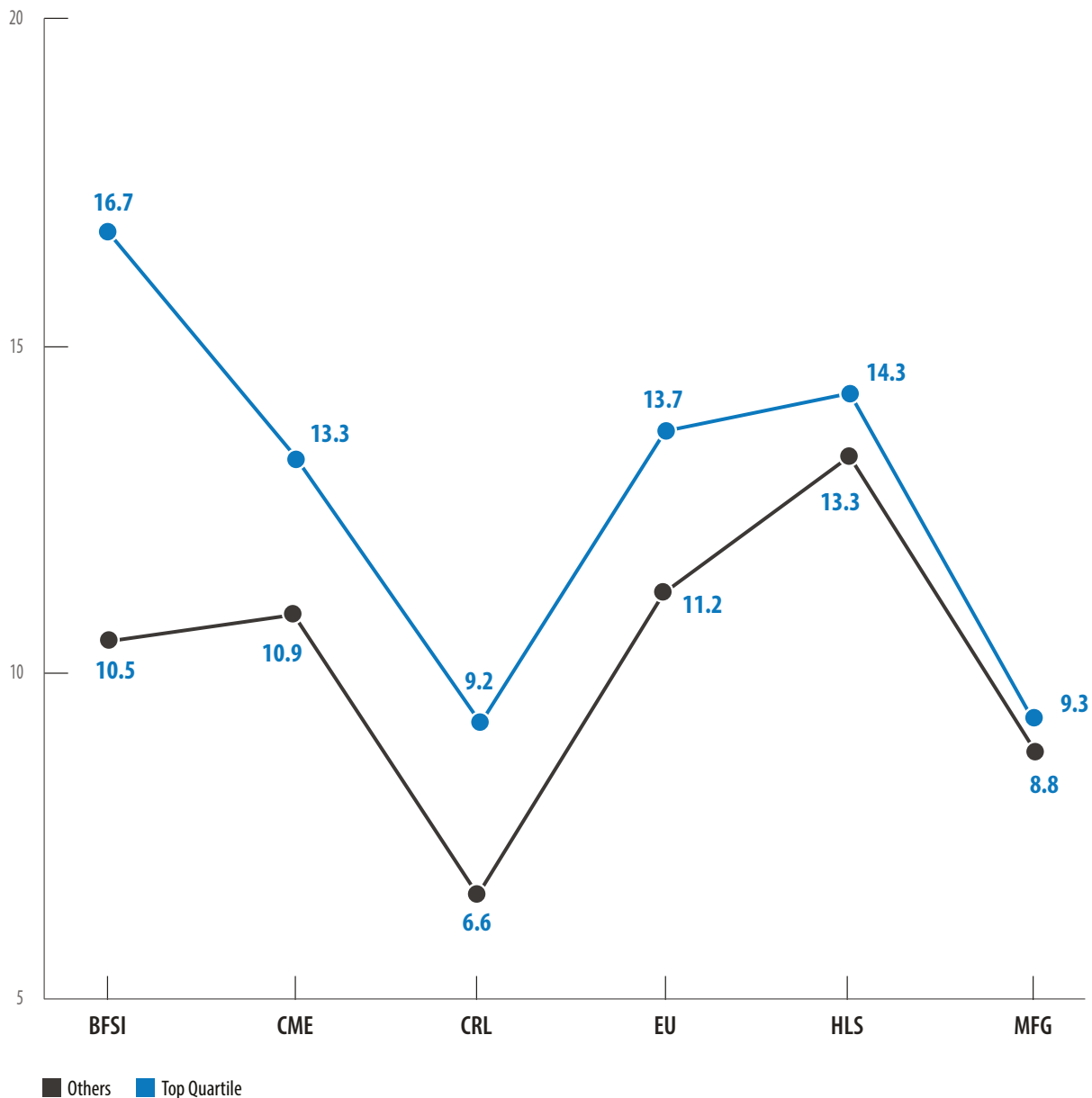
Embedding AI into operations

In a hyperproductive business environment, automation is the key player. AI is actually embedded into the enterprise systems, moving away from rules-based methods of value creation. This sort of continuously learning and evolving organization, with sentient principles woven into the whole technology stack, is the subject of Rafee Tarafdar and Jeff Kavanaugh's book "The Live Enterprise: Create a Continuously Evolving and Learning Organization."

"In our research, we've found that organizations leading in AI operations, including the ability to scale native automation, outperform laggards by as much as 6 percentage points of operating margin," says John Gikopoulos, partner at Infosys Consulting (see Figure 11).

More organizations are creating such fully automated operations. According to Gartner, by 2025, more than one-fifth of retail products will be "manufactured, packed, shipped, and delivered without being touched."[46] Our work with BP demonstrates this vision. In BP's fully autonomous store, a customer refuels their electric vehicle (EV) before walking into the store to buy something. From that moment on, everything is automated, with the customer ordering and receiving goods with almost no human interaction. Picking robots collect the chosen items (via mobile app) from storage, with the process bringing together order fulfillment, inventory management, and robot fleet management. Autonomous mobile robots use computer vision to place the chosen items on conveyor belts, which the customer then picks up from an attendant before walking out to a fully charged vehicle.

Figure 11. Effective AI operations can increase operating margins by up to 6 percentage points across industries

BFSI — Top Quartile: 16.7, Others: 10.5
CME — Top Quartile: 13.3, Others: 10.9
CRL — Top Quartile: 9.2, Others: 6.6
EU — Top Quartile: 13.7, Others: 11.2
HLS — Top Quartile: 14.3, Others: 13.3
MFG — Top Quartile: 9.3, Others: 8.8

Others ■ Top Quartile ■

Source: IKI

Implementing native automation with the focus on customer experience

Firms with a software-defined operating model (think platform-based giants, such as Amazon or Ocado in the U.K.) find it easier to automate whole value chains, such as the recruitment process or insurance claims approval. They already have a strong product-centric strategy — with a focus on how solutions and services are consumed rather than the features they exhibit — and are customer-focused. For less innovative firms, native automation can be introduced by first selecting a medium-sized business domain (see Figure 12), where automation can deliver significant business outcomes (efficiency, reliability, scalability, and agility).

Figure 12. How to introduce Native AI in your organization

| For a narrow business domain	For a broad business domain
You solve a niche problem through AI, leave route inefficiencies untouched, and don't consider interrelated processes in a business domain	Work will take over two years to complete, with return on investment not seen until then
Leaders aren't involved across the value chain, and the business owner realizes that solving the problem won't have enterprise significance	There's no clear business owner with accountability, and many business owners conflict on how to get the work done
The solution doesn't integrate with both upstream and downstream processes	The business needs to resolve underlying tech and data architecture issues to derive any meaningful value from native automation

Source: Adapted from HBR "Getting AI to Scale"[47]

The framework (Figure 4) used in our first theme — "Humans at the center of technology design and development" — can be used to work backward from a key automation goal or business process challenge. For example, when using AI to repurpose the customer experience, firms might envision what a five-star customer experience would look like and then explore in granular detail how to achieve it. This sort of innovation is progressive. For example, in the case of credit scoring customers, a firm might decide to automate the whole process. Neener Analytics, an AI credit scoring company, can be onboarded to ensure a one-click customer experience.[48] The AI used in the Neener algorithm sifts through a customer's credit history and, in 15 seconds, decides whether to offer risk products to customers. Instead of a lengthy documentation process, the AI looks at social media history and uses deep learning to

work out the likelihood of default based on customer behavior. This opens the market to customers without a credit profile (56% of Americans have either limited credit history or no history at all). For the lender, the efficiency is astronomical. This end-to-end process (see Figure 13) is an example of breaking down a manual process into constituent elements and then using AI to reimagine it from the ground up.

The focus then should be less about using RPA or automation in an ad hoc manner to make processes more efficient. Instead, whole customer journeys should be reconsidered with AI at the core. In our Agile Radar research, we found that focusing on customer journeys in this way has a remarkable effect on both business and IT success, as measured by market share, revenue, and swift software delivery.[49]

Figure 13. Neener's AI system: Automating the credit approval process
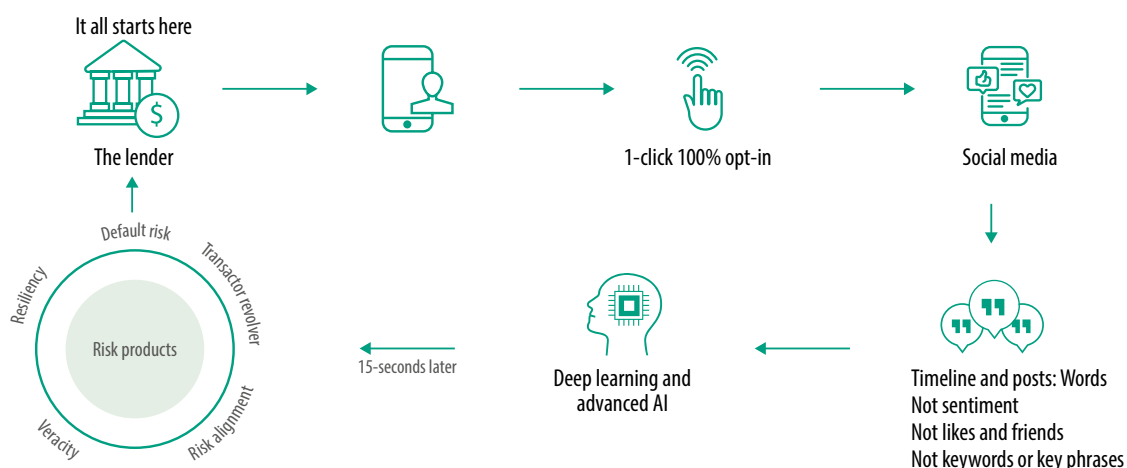
Source: IKI

Human in the loop for exception handling

Again, a human in the loop should always be available for edge cases or when real-time decision-making can be detrimental to safety. Known as exception handling, human attention is built into the autonomous system, especially where black-box AI systems and RPA are used. To get ahead, visionary firms will need to upskill their workforce and ensure partners are well versed in the systems. A proactive automation plan is also needed to ensure that automation doesn't get out of control in the enterprise.

"Executives [and chief product officers] must ask the question: How much automation is tolerable, required, and most importantly, ethical?", says Prasad Joshi, head of iCETS at Infosys. "Answers to these are a key part of system design, with the relevant objectives and key results mapped to process key performance indicators (KPIs)."

Of course, fear of job loss will be widespread when a whole process is reimagined. But AI can generate far more work than it takes away, which is the subject of the stellar book "Exponential: How Accelerating Technology Is Leaving Us Behind and What to Do About It" by Azeem Azhar. MIT, for its part, predicts that AI will enable new ways of working, and new industries will emerge.[50] This sort of reassurance will go a long way to get the whole enterprise behind the AI vision, whether that's just using NC/LC to democratize coding or automate the entire business process.
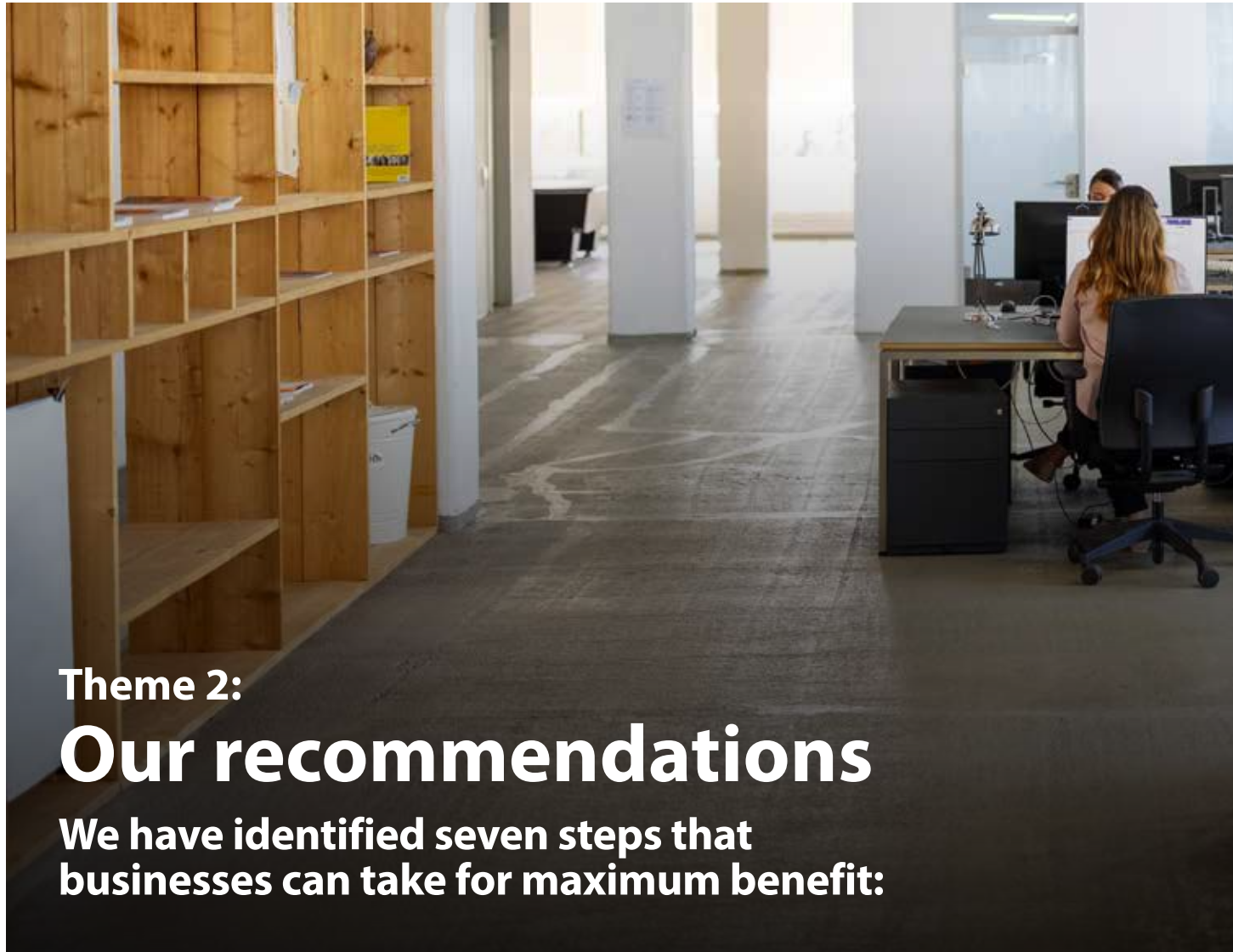
Theme 2:

Our recommendations

We have identified seven steps that businesses can take for maximum benefit:

Strategic recommendations

- **Lay out an enterprise vision for NC/LC across five key dimensions:**

    a. **Experience design,** such as omnichannel design for voice, mobile, and web

    b. **Digital experience,** such as AI-assisted development with sentience

    c. **Digital process automation [and operations],** such as advanced process intelligence with support for cognitive capabilities like NLU and image processing

    d. **Enterprise productivity,** such as AI-enabled productivity apps with pre-built models for data analytics and display

    e. **Artificial intelligence,** such as enterprise-level AI, with a shift from fragmented to integrated, managed, and monitored pipeline building and modeling

- **Use modular software to unbundle and rebundle key competencies:** Use the opportunities afforded by NC/LC to consider how to rebuild processes so that the organization is focused on customers rather than on internal processes.

- **Keep leaders in the loop on AI code generation systems:** Leaders should ensure there is someone responsible in the organization for the safe, transparent, and responsible use of AI, even as it applies to code generation.

- **Set up a cross-functional leadership team for native automation and track results:** This drive

needs to be overseen by a cross-functional leadership team. This will help drive technology investment. A good plan for measuring success is also important, using objectives and key results.

Tactical recommendations

- **Keep experienced developers and leaders to monitor NC/LC implementation:** Even though NC/LC platforms are easy to build, they require more experienced oversight to ensure that programs are stitched together effectively and properly connected to databases and transactional systems.

- **Security by design:** Data security and privacy professionals need to be involved at all stages to make sure the self-service approach doesn't compromise privacy or security.

- **Upskill the workforce to work in the democratized AI paradigm:** As firms mature in their AI journey, the whole organization will require upskilling and community development to work in an open, Agile, low-code landscape. To help here, executives should use a light-touch mode of leadership, investing power in self-contained, autonomous Agile teams that collaborate effectively across functional boundaries.

Theme 3:

The enterprise metaverse

From human-to-human to machine-to-machine symbiosis.

Why is the metaverse paradigm so important to the enterprise?

The metaverse concept has been recently popularized by Facebook but also finds applications across enterprises. We define metaverse as a world where humans are connected to digital twins of themselves (and everything else imaginable), with identities and assets completely run by computer code and transferable across platforms. The metaverse will be underpinned by the cloud continuum, edge products, and other exponential technologies, with a creator economy built around NC/LC and collaborative design and development tools.

This metaverse architecture will make enterprise professionals more productive, innovative, and successful. It will also meet people where they are in the user journey, with experiences that are more perceptive, sentient, and present.

Imagine a manager who wants to offer customers a new product to establish credibility and avoid their churn. But all the related parameters are scattered — the customer relationship management (CRM) data is in Salesforce, logistics data is trapped in an SAP system (managed by another department), and the pricing tool is archaic and poorly managed.

But in the metaverse, the enterprise cloud system knows the manager's name, access level, and the data, systems, and people needed to get the work done. It also knows how the manager and the team like to use data and has a deep understanding of their online behavior, moment to moment. In this example, the system recommends NC/LC tools with strong design elements. These tools can be quickly purchased from a self-service software marketplace, with connectors to the original databases. The manager will thus be able to provide the team with the ability to determine the right product to sell and at the right price point. And all this in days, rather than months.

This new enterprise metafabric will create completely new business and operating models. Firms poised for success will be those that use Agile methodologies widely, flatten organizational structures, and, where necessary, become platforms on which others can build products.

Microsoft is already building its stack of applications for this enterprise metaverse, with a focus on Azure Digital Twins and Microsoft Mesh, a mixed reality environment for collaborating on projects.[51] Microsoft Project Bonsai is the low code software that can plug into this stack to create intelligent autonomous systems that learn and improve over time. Even consumer majors such as Coca-Cola and Daimler are showing more interest in the enterprise metaverse concept.[52]

- **Creator economy/new experiences:** Design tools, NC/LC, cloud-based AI, asset markets, workflow, commerce, 3D engines, VR/AR/XR
- **Infrastructure:** Cloud, Blockchain, Satellites, GPUs, 5G and 6G, Edge, AI agents, microservices

Creating new metaverse experiences, more around retail, manufacturing, and health care firms, will be possible using 3D engines and XR. Demand for real-time 3D graphics skills is now especially high and increasing 601% faster than the job market overall.[53]

Demand for real-time
3D graphics skills is increasing
601%
faster than the job market overall

Collaborative design is also gaining attention, with the likes of Adobe building out a platform on which other metaverse assets will be built. Much of this work happens in the exploration layer, which includes **software and data marketplaces**. The creator economy will flourish across the **cloud continuum**. Blockchain will enable new ways of monetizing value and ensuring verifiable and transparent value chains. Satellites will enable developing economies to connect to the cloud, and 6G connection speeds may be necessary for some of the high-fidelity virtual worlds created by the bigger gaming platforms. In this spirit, we look now at what the metaverse means for design and software development and how the cloud and other layers of the stack will soon enable completely **new business and operating models**.

Sub-theme 1:
Collaborative design

Contains:
- **Stitching together design and engineering**
- **Low-cost products and real-time quality control**

The great reshuffle is occurring. Not only are people talking about when, where, and how they work, but also why they work. According to Ryan Roslansky, CEO of LinkedIn, 70% of people on the platform say they want flexibility. At the same time, 70% want human connection so that they can collaborate.[54] The enterprise metaverse can contribute here.

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> *Digital twins are increasingly adopted in the industry to help improve efficiencies, reduce costs, improve overall safety and realize sustainability goals. The enterprise metaverse can help in creating the next generation of digital twins and their adoption at scale. Overall, the metaverse has immense potential to create new business opportunities for the industry.*
>
> **Ravi Kumar GVV**
> *Engineering Head, Infosys*
>
> "

Architecting the metaverse

Regardless of platform, we believe the basic building blocks of the metaverse include:
- **Interface:** Mobile, drag-and-drop smart glasses, haptic gestures, neural interface
- **Venue:** Collaborative design, enterprisewide software systems, enterprise applications
- **Exploration:** Ratings, stores, ads, social, software and data marketplaces

Stitching together design and engineering

At its core, the metaverse is just as much about a new way of thinking as it is about the convergence of exponential technologies. And collaborative design is already charting its course in the metaverse. Designers, developers, testers, and business development professionals are using platforms from the likes of Microsoft, Adobe, and Figma to collaborate across organizations on projects of interest. Figma, founded in 2020, is a cloud native user experience (UX)/UI tool that enables real-time collaboration. The company aims to become the backbone for digital world creators. Figma is an open ecosystem, which includes community plug-ins and frictionless sharing among groups. With this plug-in open ecosystem, more designers are creating components that can be reused in different applications. "When a system has this kind of composability, it creates new building blocks, new combinations, and new kinds of creators who can all now communicate visually with each other both within and across organization," says Peter Levine of a16z.[55]

Zeplin is another collaborative design company of note. The platform increases cross-functional collaboration by designing engineering products. In our Agile Radar research, we found that the ability to collaborate across functional boundaries increases a firm's chance of growth by as much as 7% more than competitors.[56]

Nvidia, with its Omniverse platform, has entered the first phase of the enterprise metaverse. With real-time "physically accurate" simulation, clients can use the platform to create, design, and engineer complex workflows of everything from microchips to airplanes: "Omniverse is being tested by 400 companies around the world. It's used at BMW to create a digital factory. It's used by WPP, the world's largest advertising agency. And the Omniverse is used by large simulation architects," says Nvidia CEO Jensen Huang. "Bentley is using it to create digital twins. It's very important work, and worth looking at."[57]

Firms like Audi are using spatial computing, design thinking, and AR to design their newest models. With all this, people from all over the world can design a car together. Not one piece of the Audi Sky Sphere — a futuristic software platform on wheels — was designed outside of one of these virtual spaces.

> "
>
> *The 2020s may just be the decade of collaborative design.*
>
> **Peter Levine**
> *Partner at a16z*
>
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Low-cost products and real-time quality control

These sorts of use cases deliver potent benefits for businesses and customers. A lower entry barrier to design and development could see human-centric technology blossom in scale and scope. Low-cost, easy-to-build products become the norm, with more specific measurements and advanced CAD-like software. When the whole team works on projects in real time, quality control is easier. This paradigm will ultimately lead to lower customer churn and lower return rates for defective products. Further, with blockchain-based auditability and transparency, the whole design lifecycle will be more transparent for socially aware millennials.

As Levine from a16z says, the 2020s may just be the decade of collaborative design.[58]

Sub-theme 2:
Cloud continuum

Contains:
- **More cloud as firms go on the offensive, driving profits**
- **Bringing together the IoT, edge, and 5G/6G**
- **The need for zero trust networks**

More cloud as firms go on the offensive, driving profits

Much of the enterprise metaverse will be built on the cloud, which provides the huge computing power needed. Some applications will work on the edge and across the billions of fog devices, including mobile handsets, sensors, headsets, drones, and factory ware. Hyperscalers such as Google and telcos such as Verizon are already building out this infrastructure and working on applications that will work across the cloud continuum. And the appetite to use their services is growing remarkably, as proved by Cloud Radar 2021 research (see Figure 14).[59]

Figure 14. Companies with high levels of cloud adoption will more than double between 2020 and 2022

Few companies have shifted >60% tech to cloud thus far, but many intend by 2022

Under 10% | 10-19% | 20-29% | 30-39% | 40-49% | 50-59% | 60% and up
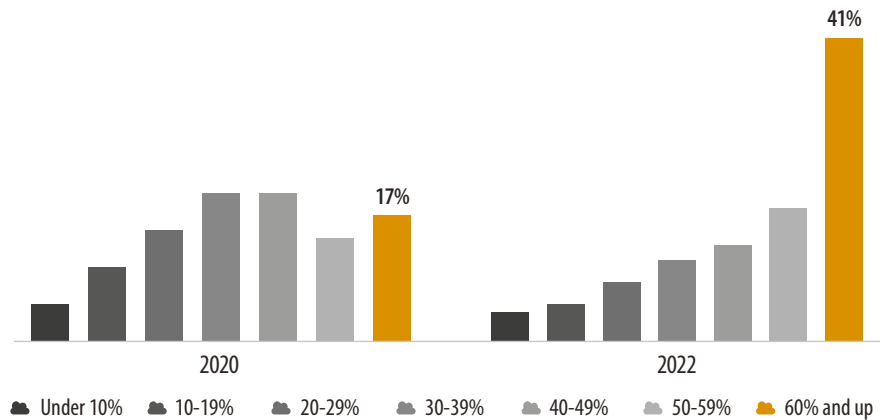
Source: Infosys Cloud Radar 2021

After a stall in 2020 due to the pandemic, firms are using the cloud to go on the offensive rather than just using the cloud to keep the lights on. Most are looking to accelerate the deployment of AI applications, improve digital capabilities, and achieve scale seamlessly (see Figure 15).
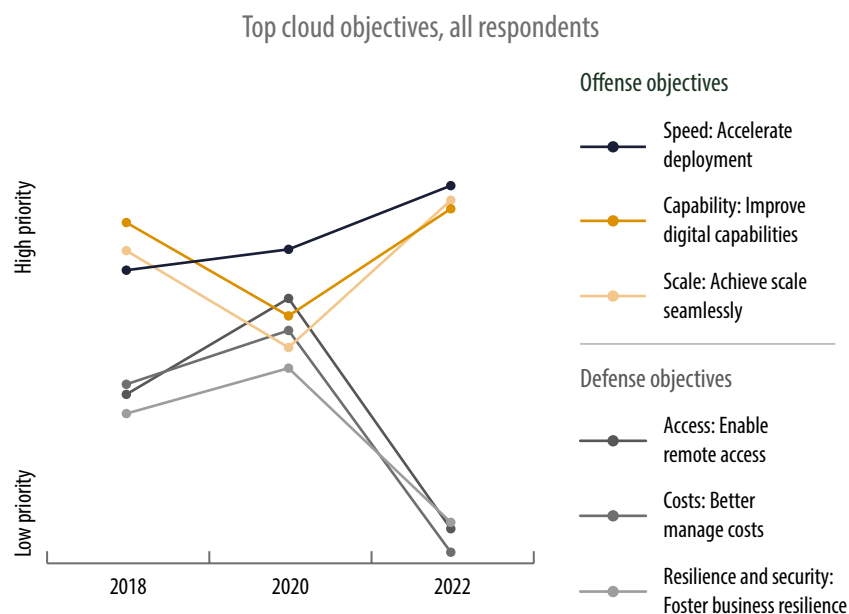
As Satish H.C. at Infosys, says: "AI and data in the cloud enables enterprises to break traditional boundaries and thrive in a collaborative and symbiotic business ecosystem."

The research found that the cloud is now used to drive revenue, growth, and new business opportunities. Effective cloud usage, according to the report, can deliver $414 billion to annual profits "in the markets surveyed by increasing the development speed and utilizing cloud capabilities to enable a competitive edge."[60]

Bringing together the IoT, edge, and 5G/6G

This competitive edge includes building data platforms that consolidate and surface enterprise data. "With the intelligent cloud and intelligent edge working in harmony, firms will be able to bring together the IoT, digital twins, and mixed reality," says Dinesh HR, EVP at Infosys. For Microsoft, using Azure will enable firms to build "a rich digital model of anything physical or logical — whether it's assets, products, a complex environment spanning people, places, things, and their interactions."[61]

Figure 15. Firms are using the cloud to go on the offensive in 2022

Top cloud objectives, all respondents

Offense objectives

Speed: Accelerate deployment

Capability: Improve digital capabilities

Scale: Achieve scale seamlessly

Defense objectives

Access: Enable remote access

Costs: Better manage costs

Resilience and security: Foster business resilience

Source: Infosys Cloud Radar 2021

Some processing will be needed on the edge. Systems that link metaverse mobile applications to enterprise supply chain software will require edge computing for enhanced data privacy and security. This means that most of the data stays on the device and reduces latency. Undergirding this sort of activity will be 5G and 6G networks, with alliances formed among hyperscalers, telcos, and other players in the edge ecosystem.[62]

The need for zero trust networks

But a note of caution. As people value this virtual world more, they truly need to safeguard cloud systems from ransomware and malware. Cloud native security will become paramount.

"Firms looking to chart a course in the metaverse must ensure security by design in cloud software systems, platforms, applications, and solutions. Zero trust network access (ZTNA) can further enhance security and improve the human experience for metaverse applications. ZTNA reduces the attack surface, improves connectivity, and doesn't directly expose applications to the internet," says Vishal Salvi, head of cybersecurity at Infosys.

To go a step further, visionary firms can use AI to protect vital infrastructure and stop unwanted intrusions. These threat identification systems can reduce the time any organization in the metaverse spends on detection, response, and remediation.[63]

Sub-theme 3:

Software and data marketplace

Contains:

- **Thriving with software and data**
- **One-picture view of the enterprise estate**
- **Case study: The Infosys Marketplace**

Thriving with software and data

Buyers and sellers of both software and data will expect consumer-grade experiences in the enterprise metaverse. Self-service will be critical. Employees will be encouraged to share new software and data artifacts that they build and deposit them in a shared space for others to use. Employees will then be able to plug together different systems using NC/LC and other connector applications. This sort of trial-and-error discovery and procurement will enable new corporate applications of AI, automation, and other exponential technologies. Taken together, these elements will increase productivity substantially and enable firms to package suites of software and data for human users across the enterprise ecosystem.

One-picture view of the enterprise estate

This sort of marketplace, when looked at through this lens, is like taking a one-picture view of the entire enterprise estate (see Figure 16).

The development of marketplaces in the enterprise metaverse will depend on the ability of firms to openly share data and software across the ecosystem. This will mean that interoperability standards will have to be defined. It also means that techniques such as federated identity management — administering applications that need access to resources in multiple security domains — will have to be used across the enterprise metaverse.

Regardless of which firms actually "own" most of the activity taking place, these marketplaces will enable high-quality assets for creators, designers, and developers to help build and monetize new IP. And asset marketplaces stand to take a central role in how the metaverse develops by 2025 — providing the creator economy with infrastructure to make their products more popular.

Figure 16. The benefits of a software and data marketplace

Simplified view of assets	– Integrated view of data – Accurate, documented, and complete – Enterprise data available, from raw to ready – Smart asset catalog, including operational, technical, and business metadata
Provide actionable assets on demand	– Self-service provision – Data and software requests fulfilled in hours – Creators can find, understand, and prepare datasets themselves – Widespread collaboration and reuse of assets
Enterprise-ready data management	– Marketplace supports new platforms – Provides mature data management capabilities – Provides security, governance, and sensitive data protection

Source: Infosys

Case study

The Infosys Marketplace

The Infosys Marketplace is a repository of artifacts, platforms, solutions, and services for Infosys' business partners and customers. It was built using a product-centric approach, with design thinking and sentient principles embedded into the design. The result is a consumer-grade experience with ratings, reviews, asset discovery, and premium services offered by teams. Along with Infosys IP, such as the DevSecOps platform and Cloud Cobalt Migration platform, 40 platforms and services from the likes of Amazon, Google, IBM, GitHub, Red Hat, and Microsoft have been onboarded. This provides further distribution channels for client IP and improves partnerships over time.

As the marketplace evolves, knowledge sharing and partner and customer co-creation capabilities will be developed. Startups and academia will have access to thousands of Infosys customers and clients. Data artifacts will be consumed in a seamless self-service portal. The UI will adapt in real time to human behavior, using sentient principles such as guided feedback and instant simulation. Feedback, alerts, and recommendations will be provided to users using Infosys Digital Brain — an AI system that understands the complete knowledge graph of the company. The idea is to increase monetization potential for all assets accessed by partners and to provide an increasingly sticky experience. In the future, Infosys Marketplace will be the gateway for sales to understand what solution Infosys has. Here, the whole business ecosystem can see what can be done when professionals work together, reuse assets that worked in practice on big client engagements, and build their own solutions in a completely self-service way.

Network effects will dominate, and the platform will get better. For instance, Amazon's marketplace is a key driver of the behemoth's e-commerce dominance. Today, third-party sellers make up over 60% of Amazon's overall retail sales, compared with 34% in 2010 and 3% in 2000.[64]

Sub-theme 4:

New business and operating models

Contains:

- **A customer-focused Agile operating model**
- **The composable enterprise**
- **The rise of blockchain**
- **The need for diverse talent**
- **Viewpoint: Why Infosys is positioned well for the enterprise metaverse**

The metaverse as imagined by

Meta and Microsoft will be worth $800 b by 2024

A customer-focused Agile operating model

This collaborative metaverse ecosystem is about creating more sensual, evocative experiences. And co-creating new experiences and solutions while opening IP to partners and customers will generate great wealth. By one estimation from Bloomberg Intelligence, the metaverse as imagined by Meta and Microsoft will be worth $800 billion by 2024.[65]

As we embed computing in the real world and vice versa, completely new ways of working will evolve. Instead of rigid hierarchy and Taylorism, the new operating model will be customer-focused and agile. It will be data driven and software-defined, following a product- and human-centric approach to value delivery. Platforms will emerge as the best way to sell products, and who gets what might just be more evenly distributed. With developers and designers outsourcing coding to citizen scientists, the knowledge economy will become even more interesting. Exponential technologies such as AI and the cloud will continue to rise in importance, as shown by our research on the subject.[66,67] Firms will come together in the metaverse to promote and advertise solutions to customers in a particular market niche and bundle offerings that promote interactions rather than transactions.

The composable enterprise

By 2025, decentralized virtual worlds will underpin many financial markets. IoT will rise in importance. Enterprises will buy or sell more real-time data collected from IoT devices so that they can better understand consumer behavior, improve sales, or build better marketing strategies. Data aggregation services will be huge, combing data marketplaces for upsell opportunities. Business API-as-product — in many ways spearheaded by AWS and Stripe, a financial services company — will come to the fore. With this monetization method, visionary leaders will help their firms unbundle and rebundle their core competencies and create leaner organizational structures that mold around the customer journey.

The rise of blockchain

Spatial computing — the virtualization of activities and interactions among machines, people, objects, and the environment — will become the way people interact with the metaverse. Screens and keyboards will become less important. The most advanced firms will follow in the footsteps of gaming companies like Unity and Unreal, using 3D engines to display geometry and animation. Expect terms like geospatial mapping, gesture recognition, biometric data integration, and next-generation UIs (that support concurrent information streams and analytics) to make their way to the top of technology trends reports. All of this will birth new ways of operating. Employees will use personalized avatars from the likes of Genies, a technology company, to work across various platforms. With virtual identities, asset marketplaces will be used to buy and sell digital goods, with non-fungible tokens (NFTs) growing in prestige. Smart contracts on the blockchain will enable transparent, permissionless, and censorship-resistant commerce. Platforms like Bitcoin, Ethereum, Flow, and Binance Smart Chain will become the foundation for this ownership economy.

The need for diverse talent

Of course, to enable this sort of change requires significant upskilling and cultural change, something our Agile Radar research proves.[68] Team autonomy, design thinking, and product agility are just a few of the buzzwords as this human-centric future unfolds. Digital alone doesn't drive profits, as our research shows.[69] The enterprise metaverse will require the unique perspective of humans. Sourcing diversified talents will be important, with gig work used by big enterprises.

Viewpoint: Why Infosys is positioned well for the enterprise metaverse

It's clear that the metaverse will be built by pulling together a range of technologies, and it will also require many different types of talent, notes Vishwa Rajan, Senior Principal Technology Architect at Infosys. "Designers, artists engineers, and tools, both digital and physical, will be needed in envisioning, creating and scaling an end-to-end solution", he says.

Infosys has already made investments in extended reality and blockchain technologies, and has worked on both internal and external initiatives, building Virtual Living Labs, an immersive world that showcases the next innovations and business models. At the same time, Infosys has already created and delivered immersive experiences that can be turned into metaverse offerings, such as

a VR store for the Australian Open, which offered shopping and commerce options and experiences such as virtual try-on.

Infosys also created the Australian Open 360, where fans could watch the live broadcast of matches with friends in an immersive space.

Rajan points to the technologies that will be drawn together, from AR and VR to spatial computing, AI and machine learning, human-computer interaction, cybersecurity, cloud, 5G and Edge. "Infosys has made some strategic investments in these technologies and talent over the past five to 10 years that places it uniquely to help enterprises on their metaverse journey", says Rajan. "Enterprises can count on our depth in business domains and expertise in immersive, interactive and experiential design for defining their use cases, business cases and execution roadmaps."

Theme 3:
Our recommendations

We have identified nine steps that businesses can take for maximum benefit:

Strategic recommendations

- **Create your own metaverse slice:** Leaders should ask the question: "How do we use the enterprise metaverse to make humans more productive and make the right decisions at the right time?" This will guide high-level business strategy and be a roadmap for implementing technologies and ways of working.

- **Invest in blockchain:** Leaders should interrogate blockchain technologies to see if they're appropriate for the business rather than jumping on a bandwagon. Be sure there isn't an established solution before you invest in a novel, unproven or controversial technology

- **Think about the workspace, workforce, and customer:** The metaverse will enable new spaces for customers to engage with businesses and their product. Creating new communicative and collaboration tools for employees and customers is the key. Also important is being empathetic to those that won't be keen to adopt new technology until it is proven.

- **Position a chief security officer as the caretaker of the metaverse:** There will always be security and privacy concerns in the metaverse. Leaders who implement use cases should ensure the chief security and privacy officers are not only aware but in control of developments in this space.

- **Think small, act big:** Building go-to-market and technical capabilities is critical in this paradigm. Leaders should increase their exposure to more business partners. Many firms prioritize five or six strategic partners who influence 70%-80% of their channel revenue. Given its inherent complexity, the metaverse will require a business to broaden its scope, working not only with peers but also innumerable smaller companies. Niche partners could include smart glass manufacturers, tracking technologies, or virtual interfaces.

Tactical recommendations

- **Collect more data for better metaverse models and processes:** Firms should collect as much data as possible on all aspects of their business as they seek to curate their own data marketplaces and sell new metaverse solutions.

- **Enable hybrid cloud and high-performance chips:** The massive amounts of data and networking needed for the metaverse require scalable cloud computing. Along with edge and high-performance graphical processing units, this will enable firms to move seamlessly among metaverse platforms.

- **Hire, hire, hire:** Executives should think about the sorts of metaverse roles they should start hiring for. Prestigious roles include those at the intersection of AR, VR, gaming, blockchain, AI, 5G, and other web3 technologies.

- **Use a systems integrator to do the hard work:** Businesses should work with system integrators to

increase their interactive and product-envisioning capabilities, going beyond just mobile apps, next-gen websites, and commerce platforms. Help will also be needed to envision, design, and operate limitless infrastructure platforms, with aptitude in the cloud, edge, 5G, carriers, and blockchain. Further work will need to be done on maximizing monetization models, with breakthrough thinking around potential revenue streams. For example, a bank or a telecom company will want the enterprise metaverse to influence growth and not just become one more channel of customer experience.

Toward the human-centric future

The need for as much heart as head.

The human-centric future is upon us!

Firms must adapt and make better human-centric outcomes. **Those that make humans the center of both business and operating models will be the firms of the future**. They live and breathe as a sentient organism, reacting to signals in the wider market while simultaneously homing in on the unique desires, frustrations, and almost mystical approval of individuals.

Significant enterprise upskilling and reskilling will drive this future. Building new human-centric solutions with purpose and privacy at the core will lead to more data and design professionals who use systems thinking to factor in a wider range of human perspectives.

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> *Humans want to be treated as agents of their own destiny; we saw this in the pandemic's most challenging hours. ESG goals once latent have now become cornerstones of boardroom debate. Firms must act without layers of authority constraining every decision. Less administration, more risk-taking – that is the winning combination for a sustainable future.*
>
> **Jeff Kavanaugh**
> *Head of Infosys Knowledge Institute*
>
> "

Hyperproductivity will give birth to many more citizen AI experts. And to thrive in the metaverse, creativity, design thinking, and an insatiable curiosity to interact, engage, and learn from other human beings will take center stage.

What are business leaders searching for? More money? Well, the most successful, effective, and profitable organizations have a stronger and broader vision beyond money.

Perhaps what these leaders really mean by more ESG investment, better experiences, sentience, or even collaborative ecosystems of highly productive humans is a better, responsible virtual world. Here, leadership is hearty, humble, and innovative. It knows how to access the best talent and ideas, generate insights from AI, and codevelop and tie together new services and solutions.

We now know that businesses should adopt technologies with humans in mind. Those that consider the human element throughout the product lifecycle and those that use as much heart as head will win customers, partners, and the world at large. In this spirit, the need for a human-centric future built around technology is a call to action for all organizations, for all people. And that's how we will enter the technology-enabled, human-centric future.

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