

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Digital Banking Manifesto: The End of Banks?

Alex Lipton, David Shrier, Alex Pentland
Connection Science & Engineering
Massachusetts Institute of Technology

connection.mit.edu



Massachusetts
Institute of
Technology



MIT Connection Science
the technology of innovation

This paper is part of our financial technology innovation series:

- Blockchain & Financial Services
 - 5th Horizon of Networked Innovation
 - Transactions, Markets & Marketplaces
 - Infrastructure (Identity, Data Security)
- Mobile Money & Payments
- Prediction Markets
- Policy & Financial Technology
- Digital Banking Manifesto

Disclaimer

The Massachusetts Institute of Technology may have financial or other relationships with one or more entities described in this document. No endorsement, implied or explicit, is intended by discussing any of the organizations or individuals mentioned herein, and is expressly disclaimed.



I. Introduction

"Banks are trying to be cool and hip and build super cool digital front ends... But it's like putting lipstick on a pig - ultimately it's still a pig and the new front end is still running into an awful digital back end."

Mark Mullen, Chief Executive Atom, Durham, UK

We are entering a new era of innovation that will reshape consumers' relationships with their banks. In order to understand how banking will evolve in the digital age, it is important to understand its basic premise. While reasonable people can disagree about nuances, at heart, the art of banking is one of skillful record keeping in the double-entry general ledger. At micro level, banks can be thought of as dividend producing machines seeking deposits and issuing loans. At macro level, they are creators of credit money.¹ The main determinants of their quality and reliability are the amount of capital and the level of liquidity (essentially central bank money) they keep. In general, a bank would like to maintain the right levels of both – if it has too little, it becomes fragile, if it has too much, it becomes unprofitable and hence unable to fulfill its purpose of paying dividends. Some of the loans issued by the bank will be repaid as expected, and some will default. In general, when loans are repaid, the bank's capital grows and when they default, the capital diminishes. If the bank's capital falls below a certain fraction of its risk-weighted assets, the bank defaults. Good bankers differ from bad ones by their ability to attract a large pool of reliable borrowers, so that default levels stay close to their expected values. (Some defaults are inevitable and are accounted for by charging interest.) At the same time, good bankers need to attract long-term depositors and serve them well, so that depositors do not suddenly withdraw their deposits. If the latter were to happen, the bank can exhaust its liquid reserves and default through a different route. In principle, if its less liquid assets are sound, the central bank, which is called the lender of last resort for a reason, can come to the rescue and provide additional liquidity.



It is clear from the above description that banking activity is mostly technological and mathematical in nature. Hence, it is well suited to be digitized, yet the prevalence of legacy systems and legacy culture inhibits banks from embracing innovation as much as they should in order to survive and thrive in the digital economy of the 21 century. The root causes of banking malaise should be obvious – old-fashioned banks are far behind the latest technological breakthroughs; they also have a poor handle of the risks on their books. While major industries, including retail, travel, communications, and mass media have undergone revolutionary changes in their business models in the last thirty years or so, banking remained static at its core, living on its past glories and ignoring the winds of changes. Existing banks suffer from numerous drawbacks, because competition among them is relatively weak. Moreover, their customers are generally not happy with the level of customer service they receive, besides, they are exposed to the risk of losing their deposits (above and beyond the regulatory guaranteed minimum) in the case of their bank's default. Zero or negative deposit rates, which became prevalent in most developed countries in recent years, make keeping money in the bank both risky and unprofitable. Yet, at present, customers do not have viable alternatives.

In addition, there are whole strata of people and SME, especially in developing countries, who are either underbanked or unbanked, due to the fact that traditional banking methods are not flexible enough either to solve the know your customer (KYC) problem for them or to assess their credit worthiness.

Thanks to new developments in data technology and in mobile telecommunications adoption, we see the potential rise of a third wave of innovation in banking. We will outline in this paper the key features, benefits, and strategic imperative of the Digital Bank of the Future (DBF).

To understand the opportunity that is promulgating this third wave, we define the first two waves of digital innovation in banking:

First wave companies: the “incrementalists”

Digital technologies have been entering the banking industry for years. However, they have been added incrementally to existing operations, either as an overlay or a minor extension. We term these the “incrementalists” or First Wave companies.

In the mid 1970s, Citi began experimenting with the automated teller machine (ATM). Former MIT Chairman John Reed led the development of Citi's efforts in this area, revolutionizing retail banking. The ATM story is a landmark study in corporate innovation. The concept was simple: deploy machines that could process transactions such as cash withdrawals and check deposits. What was revolutionary was what followed: banks historically had been open with limited daytime hours, say 9am – 3pm, which was inconvenient for people who had a job. However, in the 1950's, most householders in the U.S. had a single earner, and the stay-at-home-wife was able to handle banking needs during the day. Mapping to a behavior change in society, as more and more women entered the workforce, the U.S. saw a rise in two-income households, which in turn led to a diminution in the ability of people to take advantage of daytime banking services. Thanks to computerized banking, executives could see exactly when people most needed to use banking services. Evening utilization of ATMs surged. Banks, in turn, then began extending their hours into the evening to accommodate the working professional. By 2014, there were 524,000 tellers in the U.S.², up from 484,000 in 1985³.

Online banking, likewise, was piloted in the 1980s by Citi, Chemical Bank, through Minitel (France), and Prestel (UK), but didn't really take off until the 1990s in conjunction with soaring internet usage. Simple, browser-based tools gave consumers access to a number of key banking transactions such as money transfer, bank statements, and electronic bill payment. While the incumbent commercial banks initially were the purveyors of online banking, the rise of the internet also saw the rise of the internet bank – most prominently NetBank in 1996.

Second wave companies: digital hybrids

We term the Second Wave companies like NetBank to be “Digital Hybrids”. Frequently taking advantage of front end systems to better market and connect with consumers, they remain shackled by legacy back and middle office infrastructure, risk modeling systems, and sometimes labor models. Often these hybrid banks will have an incumbent bank as their backend.

For example, Simple Bank was founded in 2009 with a number of innovations to streamline account management and costs, but uses The Bancorp as its backend.

Other emergent hybrid banks such as Fidor Bank (Germany), Atom Bank (UK), LHV Pank (Estonia), and DBS Digibank (Singapore) enjoy purpose-built IT infrastructure that is 60-80% less expensive to build, and 30-50% less expensive to maintain, than legacy banks. Headcount is considerably lower, about 10-15% the levels of a traditional bank.

However, these “digital hybrids” still use centralized databases, cloud based storage and primitive user data protocols. They represent a bridge solution between the Main Street bank of yesterday and the fully digital bank of the future.

Third wave companies: digital natives

A new set of technologies is emerging that permit close integration with consumers' lives, promise access to the 2.5 billion unbanked or underbanked consumers globally⁴, and greater financial flexibility to 45+ million underbanked Small & Medium-sized Enterprises (SMEs) around the world⁵.

DBF will take advantage of these technologies and be designed around the needs of digital natives, the 50 and under crowd that grew up with computers as a daily part of their lives. For the millennials, a mobile-first strategy will drive ease of access and rapid adoption through seamless integration with their lives.

Taking a breakthrough approach to data security, DBF will eschew a central data repository, easily attacked, in favor of a secure, encrypted, distributed data system. Personal data stores not only permit better digital walleting, but also greater security around personal biometric data which is integral to the digital bank's security protocols.

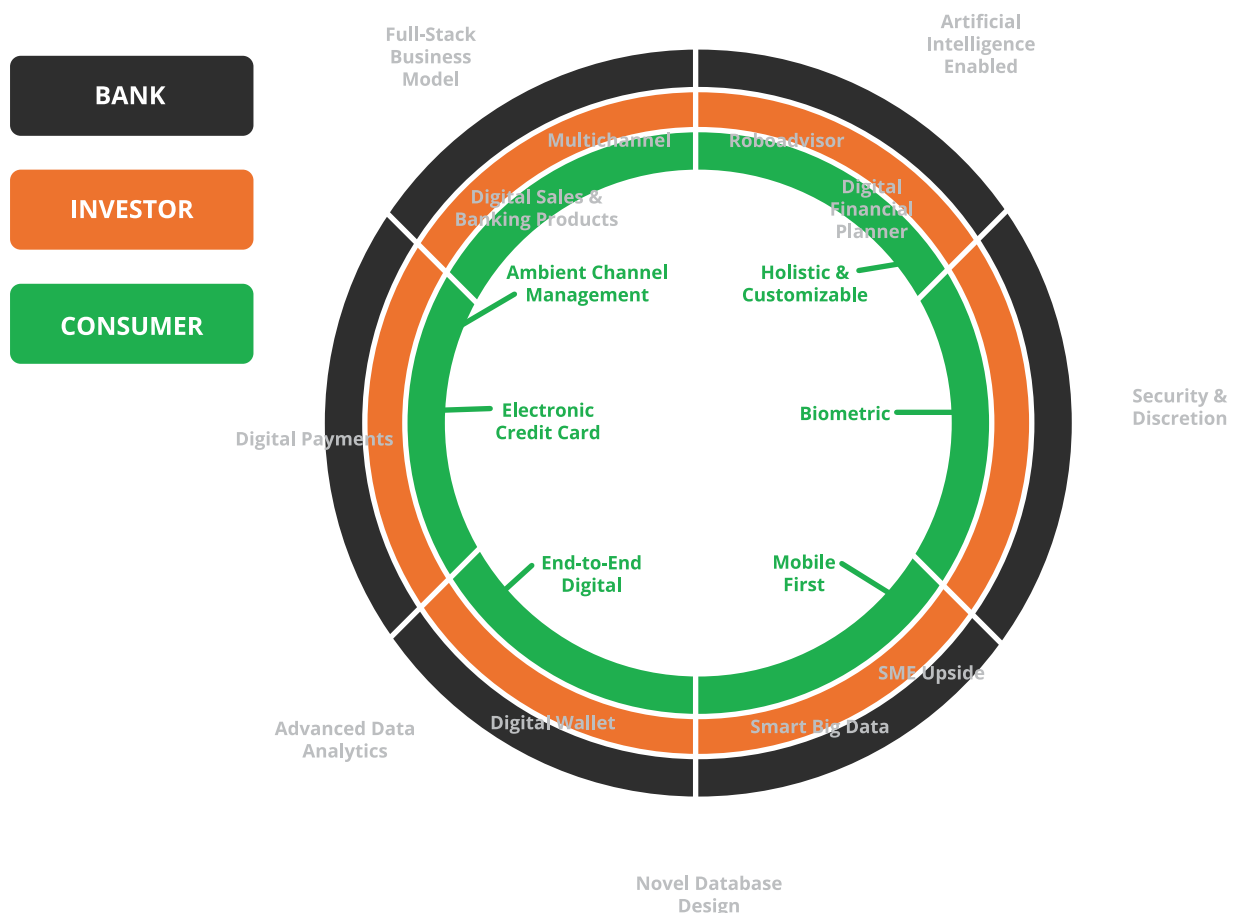
The new technology paradigm begs the question: what role do banks truly have in the new world? Have we reached the end of banks in the way we know them? Is it possible that fractional banking is on its last legs and the introduction of government issued digital cash which can be stored in a digital wallet outside the banking system will put the last nail in its coffin?

We will now look at the key requirements for a digital bank from three perspectives: customer, investor, and the bank itself.



II. Key Requirements for a Digital Bank – Customers' Perspective

Consumer View of Future Digital Bank

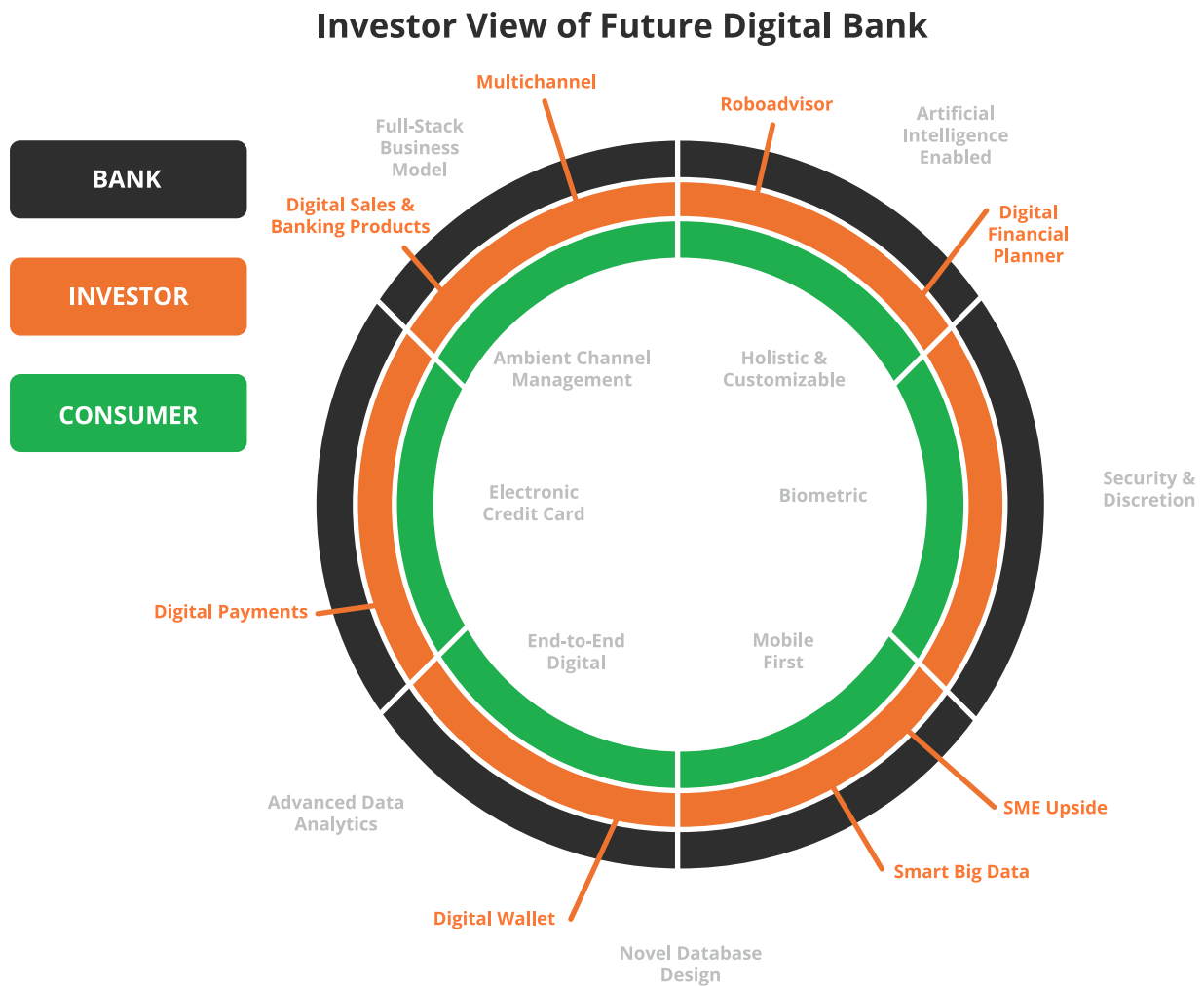


At a minimum, on the retail side, DBF should be able to do the following:

- **Holistic & Customizable Experience** Provide a holistic, interactive, and intuitive overview of the customers' money and, more broadly, their financial life, including information on their current account and deposit balances, transactions, outstanding loans, recurring payments, pension contributions and accumulation as well as securities accounts. Tailor its services for different customer segments such as small and informal merchants, mass affluent, youth market, international travelers, or low-income customers. Offer a trusted and relatively inexpensive source of credit for its customers;

- **End-to-End Digital** Provide a holistic fully digital experience for customers, including, paperless application and passing of the KYC (Know Your Client) process. Also provide an interactive and intuitive digital financial planner to organize customers' financial life and optimize their resources: immediate cash flow requirements, savings, including tools for automatic savings, medical expenses, education, retirement, including robo-advisory with services previously accessible by high end investors only, investments, including tools for trading securities. Empower customers to electronically apply for mortgage or loan, competitive insurance contracts for home, liability, medical and travel insurance, with credit checking procedures expanded to social media. Provide reporting documentation related to bank activity, including tax statements, etc. Provide access to Personal Data Store (PDS);
- **Mobile First** Enable natively driven mobile e-payment solutions, including domestic and international payments and remittances, automatic bill payments, and peer-to-peer (P2P) payments and money transfers. Rather than having mobile as an afterthought or an added capability, everything changes if you start with mobile and build out from there – not just UX but fundamental infrastructure and credit analytics;
- **Foreign Exchange** Deliver seamless and inexpensive foreign exchange services, including protection against exchange rate fluctuations by providing multi-currency accounts. Potentially, a full range of instruments for hedging against foreign exchange risk, including forward contracts, spot contracts, swaps, and exchange traded options can be offered;
- **Biometrics** Offer biometric technology such as face and voice biometrics, already actively used at airports and international border controls, as core credentials for customers with preference for biometrics to PIN or password as a way of authentication for logging in. Behavioral biometric, which is being developed at the moment, is a promising venue for achieving an extra degree of protection;
- **E-Credit Card** Implement bank e-credit card based on customer's own preferences with pre-set limits and permitted transactions, consumption-related patterns, and a comprehensive digital wallet and PDS, which includes, at the minimum, electronic ID, e-card for secure online purchases, and tools to view, pay, organize, analyze, archive e-bills, and generate relevant tax documents;
- **Access to P2P World** Provide access to “crowd-everything” including P2P payment and lending opportunities.

III. Key Requirements for a Digital Bank – Investor Perspective



Digital bank is an exciting investment opportunity and inevitable business step because legacy banks are no longer able to adequately service their customers' needs in the digital age. Customer requirements simply cannot be met by traditional banks unable to catch up with the digital revolution. With neither real estate overhead, nor massive maintenance spending on legacy IT systems, digital banks expect to grow multibillion dollar balance sheets in several years of operations with the fraction of full time staff compared to traditional banks. For instance, Atom Bank in the UK intends to grow into a £5 billion balance sheet business in five years with just 340 full time staff, while legacy bank Metro has that size balance sheet with 2,200 people. It is clear, however, that the majority of digital banks' staff will be engineers and data scientists, although, as always, the role of sales and marketing should not be underestimated.

Monetization and capturing value

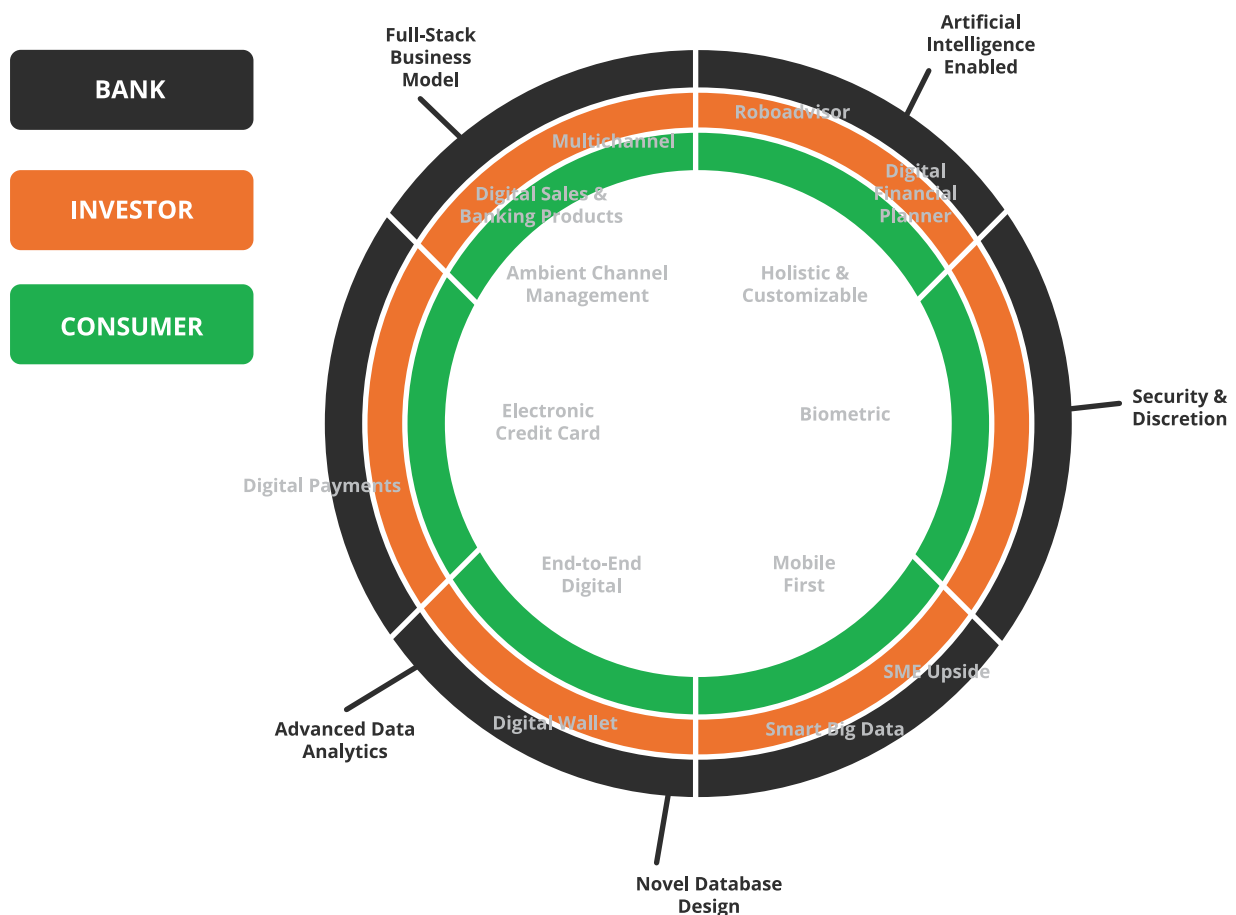
Compared to legacy banks, digital banks can generate value in numerous ways:

- **Digital Payments** Digital payments form the core of monetization. They include mobile and online payments, both domestic and foreign, as well as mobile P2P interactions. Digital payments enable banks to boost fees and interest income and reach a broader set of customers with more diverse services; they are done more cost effectively than by incumbent banks, allowing market share gains through competitive pricing and/or accessing 2.5bn unbanked & underbanked;
- **Digital wallet** Digital wallet is essential for digital commerce and ecosystems built on value-added services. In addition, it optimizes transaction costs for customers and funding costs for banking operations;
- **Digital Sales & Banking Products** Artificial intelligence (AI) assisted sales of banking products, such as deposits, loans, and mortgages are conducted through direct channels, including social media. That is in line with shifting consumer preferences and behavior trends in e-commerce, especially directed at Generation Y and tech-savvy customers;
- **Multichanneling** An integrated and seamless multichannel approach to sales increases the bank's share of customers' wallet, boosts customer loyalty, thereby making a significant difference in customer adoption rates;
- **Digital Financial Planner & Roboadvisory** AI-based digital financial planner manages monthly income, recurring payments, savings and investments, increasing interaction between the digital bank and customers. The bank acts as a trusted shepherd defining customer life-cycle financial needs. Logical continuation of the circle of trust between the digital bank and customers, where customers rely on the Roboadvisory services to optimize investment portfolios based on individual goals and preferences, regularly adjust them and record incremental results and properly allocate resources for each phase of the customer's voyage towards all things digital;
- **Smart Big Data** Advanced analytics allows the digital bank to transform its data into more personalized client service aimed at data monetization;
- **SME Upside** AI- and big-data based credit models enabling risk-managed provisioning of credit access to SMEs, banking the 45 million underbanked SMEs globally. By 2018, banks in Scandinavia, the United Kingdom, and Western Europe are forecast to have half or more of new inflow revenue coming from digital related activities in most products, such as savings and term deposits, and bank services to SMEs⁶.

IV. Key Requirements for a Digital Bank – Bank's Perspective

"Banks are mired in the legacy of old IT systems that are bad... The first automated banking system was introduced by Coutts in 1967. The joke is that they are still running on it today." The only saving grace is that banks are not unique in this respect. For instance, as was revealed by a recent government report, the US nuclear weapons force still relies on a 1970s-era computer system and 8-inch floppy disks.

Bank's View of Future Digital Bank



By its very nature, a digital bank has to be a cross between a Fintech company and a bank. While a digital bank, similarly to a conventional one, can be organized into five divisions: Retail Banking, Private and Business Banking, Analytics and IT, Finance Management and Operations, and Risk Management, the relative importance of these departments is not the same. Moreover, the relationship map between various divisions is different in digital and legacy banking, with analytics and IT being the cornerstone of the digital banking edifice. In general, success and failure of a bank is measurable by technologies and analytical methods adopted rather than by its product line.

- **Novel IT Infrastructure** Building a digital bank from scratch enables to create a flexible IT infrastructure, which provides state of the art risk management, helps to optimize the bank's balance sheet to achieve return on capital significantly higher than return of the incumbents, and guarantees compliance with constantly changing banking regulations in real time, which is achieved via building modern RegTech capabilities.
- **Database Design** The bank IT is based on the state-of-the-art database technology, which can cope with the exponential growth in data, new internet technologies and analysis methods. This technology is expected to be based on distributed ledger framework.
- **Advanced Data Analytics** Since banks own rich reserves of raw behavioral data, which can provide valuable insights into future customer choices, the value proposition offered by digital banking can be extended. Following the example of Internet powerhouses, such as Google, Amazon, Alibaba, and Facebook, the bank should consolidate data across deposits, consumer finance, and other transaction accounts for a unified view of customer activities. For instance, customers' in-store payments are far more accurate than conventional profile data (for example, age, income, geography) in predicting their future financial activities and credit worthiness; their geospatial mobility among stores providing extra improvements. In addition, using customer data, digital banks can create offerings ranging from payment solutions and information services, savings and deposit-taking right through to online banking, advisory services, and simple financing. It is imperative to be able to evaluate collected customer transactions in real time and connect them for prediction of future customer behavior using deep learning and other probabilistic algorithms. It is important to build in safeguards of customer privacy in accordance with their preferences and legal requirements.
- **Artificial Intelligence** Autonomous selection of best methodology when presented with arbitrary data enables banks to dynamically adopt to novel information and build a full financial profile of its customers, including credit worthiness, debt capacity, and risk appetite for financial planning. In addition, AI can rapidly adapt to customer needs and present the best offers at the right time, changing dynamically as the customer evolves. A "smart bank" can more rapidly capitalize on shifts in a customer's life cycle and assist them in achieving their financial goals.

- **Full-Stack Business Model** The full-stack business model is crucial to the total client experience. This approach facilitates the bank's compliance with the regulatory framework, which enforces money laundering and fraud prevention and guarantees customers' protection. In general, intelligent fraud detection and remediation systems can function in a far more superior fashion than conventional methods.
- **Security and Discretion** If implemented correctly, bulletproof security and customer protection is the area of a great competitive advantage for digital banks compared to other financial service providers. These features are embedded in a secure IT architecture from the onset and preclude both data misuse and data sales to third parties. They naturally include implementation of new cryptographically secured distributed data management ⁷.



V. Digital Customer Segment

Digital banks have several natural constituencies in both developed and, especially, developing economies ⁸:

- Professional consumers with at least an undergraduate college education;
- Digitally educated middle upper-mass and mass-affluent professional and managerial consumers;
- Digitally savvy Gen Y (students and young professionals in their 20s to 30s) digital-banking natives, who are exceedingly digitally savvy. They will form the foundation of the customer base for the digital bank;
- SMEs that go mainstream using a digital banking platform designed for their needs; potentially banking 45 million underbanked or unbanked SMEs globally ⁹.



VI. Unleashing Digital Currency

Digital banking of the future is unimaginable without using digital currency ¹⁰. Currently, both central and private banks are actively pursuing creation of digital currencies. Some considerations for this dimension:

- **Non-Bank Digital Currencies** While the best known digital currency is Bitcoin, it's not suited for high volume transactions because of its low transactions per second (TPS) capacity. It is likely that other digital currencies based on consensus achievable by means other than proof-of-work will be used in digital banking. One should not forget that Bitcoin is not the first digital currency to emerge, nor is it going to be the last. In fact, it is possible that digital cash invented by David Chaum more than thirty years ago can see a comeback at the next level of efficiency.
- **Central Bank Digital Currencies** Several central banks are investigating whether a state-backed digital currency could reduce capital outflow, money laundering and tax evasion, and make economic activity more transparent and efficient. For instance, PBOC, BoE and Bank of Russia are all actively looking in this direction. In this scenario, the "free" (or very inexpensive) deposits that commercial banks have been benefiting from will evaporate.
- **Private Bank Digital Currencies** The idea of banks issuing their own currency is very old. For instance, dozens of banks in the United States were doing so in the nineteenth century. Advances in digitization made this idea viable again. For example, Bank of Tokyo Mitsubishi UFJ (MUFJ) is developing its own digital currency, MUFG coin, and the corresponding smartphone application prototype to authenticate digital tokens on a P2P platform. The bank expects to rein in financial transactional costs, including cheaper international remittance and money transfers. Moreover, in the future the bank might potentially issue its digital currency to customers.¹¹
- **Distributed Ledger** Using distributed ledger reduces financial transaction costs, improves resilience of the system as a whole, and mitigates operational risks. Without doubt, distributed ledger will become intertwined with operational procedures of a digital bank and its interactions with other digital, legacy and central banks.

VII. Ecosystem

It is natural to expect that a well-designed digital bank will become the corner stone of a much bigger financial ecosystem. As important constituent parts of such an ecosystem, one can think of such digital service providers as insurers, brokers, wealth managers, robo-advisors, credit card issuers, cross-border payment providers, currency exchanges, P2P lenders, etc. The ability of these companies to satisfy the financial needs of their clients will be greatly enhanced by their access to a wider financial system through the digital bank. At the same, the bank will benefit by getting additional information about their customers' demands and habits, thus closing the information feedback loop¹². Moreover, digital cash issued by the bank can serve as a lubricant allowing the wheels of commerce to spin faster and much more efficiently than is currently possible. It is possible to imagine a digital bank of the future in the center of the internet of things (IoT), which can be thought of as the bank of things (BoT). For instance, if a bank's client house informs him or her that the roof needs repairs, the bank can immediately recommend several contractors, organize bids, help the client to choose the most suitable one, and arrange financing. Thus, in addition to financial businesses, a digital bank of the future can incorporate into its ecosystem various non-financial actors. All these developments will enhance social utility of the bank and its appreciation by the public while, at the same time, increasing its profitability. Banks have to keep in mind that there is no time to lose, because the competition for their customers' digital wallet from current digital champions, such as Google, Amazon, Facebook and Alibaba, will be fierce.



VIII. Beyond Banks

The unsatisfactory state of affairs with existing banks opens a unique opportunity for building a digital bank from scratch. Such a bank will fulfill its mission by utilizing the most advanced technologies, including cryptography and distributed ledger techniques, artificial intelligence, big data, and deep learning. From the very beginning, it will be based on balance sheet optimization, deployment of digital distributed ledger-inspired infrastructure, and comprehensive automation and digitization of the middle and back office, as well as a heightened security employing the most advanced cryptographic techniques throughout the entire organization. By design, this bank will be highly efficient, profitable and agile. In addition, its infrastructure will be flexible enough to handle both private digital currencies (such as Bitcoin) and potential government issued currencies (such as Britcoin). If so desired, this bank will be capable of issuing its own digital currency. The bank will liberally apply artificial intelligence and big data analytics for creating unparalleled customer experience, automating personal and SME credit issuance, and improving risk management. By design, such a bank will be valued by investors, customers, and regulators alike.

And yet, by building a bank, are we trapped in the old paradigm?

If you look at WeChat or Sesame, you will see what is scaring the C-level of even leading edge companies like Facebook and Google, to say nothing of the fright induced at leading telecommunications companies. Perhaps surprisingly, many legacy banks seem to be more sanguine. WeChat is redefining what financial services means in relation to the broader suite of consumer services individuals engage with.

The key is having customer-centric data across all areas of life, held in standard format with standard APIs that work across all the entire digital ecosystem and not just its financial services or products corner (like a universal PDS, but customers don't own or manage it; they do). Using this central, panoptic data, WeChat can integrate services from the whole range of life opportunities (entertainment, work, finance, family, etc.) in a seamless and consistent manner.

What this gives customers is fully integrated payments, credit and banking, unbelievable advising capability and amazing KYC and AML, all in a form that is completely transparent. Consumers don't need to know that payments are different from credit or from banking or from shopping in general. Users just wander around online and in-person, finding interesting things and buy, sell and trade seamlessly. WeChat or Sesame is also integrating health, lifestyle and employment services with money services - completely transparently; no separate apps or web pages. You can just take care of what you need to live a better life. However, this is conditional on consumers' ability to secure credit as necessary. Given the rather uncertain and limited capacity of P2P networks to provide credit, digital banks have to come to the rescue.

A similar future is unfolding for SMEs: customers are shepherded to buy and money flow issues like credit, payments, KYC and AML go away virtually completely. WeChat reportedly reached over one million SMEs integrated into their services in the first few months of operations.

Is there a future that is NO banking versus “digital banking”? Instead, banking functions are just integrated invisibly everywhere. Several immediate challenges come to mind with this model:

- Due to the special and unique role of banks in credit money creation, non-bank actors simply do not have necessary capacity to satisfy the financial needs of their customers;
- There are numerous constraints around offering banking services that may be too limiting for companies in western Europe and the US. If China begins to adopt more restrictive financial regulations to better protect consumers, they too will create a less hospitable business environment for these kinds of services.
- Will WeChat (or the next WeChat) want to take its high flying tech company stock market multiple, and burden it with a financial services discount ¹³? The more successful it gets at financial services, the more acute this question becomes. However, if financialization of a tech company is done in a deliberate and measured way, it can actually increase the shareholder value.

Despite these challenges, is there a model that we could call “invisible banking” that integrates into our daily lives without friction? The answer is yes and no – the legacy banking model will unquestionably disappear over time, but in the transition period, digital banks will have a role in daily life for the foreseeable future as transaction lubricants and enablers.

THE FINANCIAL WORLD IS FOCUSED ON FINTECH. ARE YOU?

If you don't want to get left behind, consider updating your expertise and upskilling yourself with this **12-week online certificate course from MIT.**



EXperimental
Learning

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Fintech certificate course: Future Commerce

Presented in collaboration with leaders in online education, GetSmarter.

getsmarter.mit.edu




"You need to understand what's going on in this highly chaotic environment. And we can help."

DAVE SHRIER - MANAGING DIRECTOR, MIT CONNECTION SCIENCE; LEAD INSTRUCTOR



SA+P

Massachusetts Institute of Technology | School of Architecture + Planning

IN COLLABORATION WITH  **getsmarter**

REFERENCES

- ¹ A. Lipton (2016), "Modern monetary circuit theory" IJTAF. This paper provides detail explanation of how money is created and destroyed by the banking system as a whole and by individual banks. It also shows that individual banks become naturally interconnected in the process.
- ² Bureau of Labor Statistics (2015), "Occupational Outlook Handbook" <http://www.bls.gov/ooh/office-and-administrative-support/tellers.htm>
- ³ E. Florian (2004), "The Money Machines The humble ATM revolutionized the way we deal with money and turned global commerce into a 24/7 affair. You can thank a Texan named Don Wetzel--and the blizzard of 1978" http://archive.fortune.com/magazines/fortune/fortune_archive/2004/07/26/377172/index.htm
- ⁴ Chaia I, Goland T, Schiff R (2010) "Counting the World's Unbanked" <http://www.mckinsey.com/industries/financial-services/our-insights/counting-the-worlds-unbanked>
- ⁵ IFC Advisory Services (2011) "Access To Credit Among Micro, Small, And Medium Enterprises" <http://www.ifc.org/wps/wcm/connect/1f2c968041689903950bb79e78015671/AccessCreditMSME-Brochure-Final.pdf?MOD=AJPERES>
- ⁶ H. Broeders and S. Khanna (2015), "Strategic choices for banks in the digital age", McKinsey & Company
- ⁷ G. Prisco (2015) "Enigma, MIT Media Lab's Blockchain-based Encrypted Data Marketplace, to Launch Beta" <https://bitcoinmagazine.com/articles/enigma-mit-media-lab-s-blockchain-based-encrypted-data-marketplace-to-launch-beta-1450810499>
- ⁸ For example, in Asia the number of potential digital-banking consumers could be as high as 1.7 billion by 2020, see J. Chen, V. HV, K. Lam (2015), "How to prepare for Asia's digital-banking boom", McKinsey & Company
- ⁹ D. Shrier, J. Larossi, D. Sharma and A. Pentland (2016) "Blockchain & Transactions, Markets and Marketplaces" <http://resources.getsmarter.ac/other/the-mit-report-on-blockchain-part-2/>
- ¹⁰ D. Shrier, G. Canale and A. Pentland (2016) "Mobile Money & Payments: Technology Trends" <http://resources.getsmarter.ac/other/mobile-money-payments-technology-trends-an-mit-white-paper/>
- ¹¹ S. Das (2016) "Japanese Banking Giant Reveals Plans for a Digital Currency" <https://www.cryptocoinsnews.com/japanese-banking-giant-reveals-plans-for-a-digital-currency/>
- ¹² It is necessary to provide customers with proper privacy safeguards.
- ¹³ It is possible that both tech premium and financial discount are temporary in nature.