DeepLearning.AI

AI Transformation Playbook

How to lead your company into the AI era

by Andrew Ng

AI (Artificial Intelligence) technology is now poised to transform every industry, just as electricity did 100 years ago. Between now and 2030, it will create an estimated $13 trillion of GDP growth.[1] While it has already created tremendous value in leading technology companies such as Google, Baidu, Microsoft and Facebook, much of the additional waves of value creation will go beyond the software sector.

This **AI Transformation Playbook** draws on insights gleaned from leading the Google Brain team and the Baidu AI Group, which played leading roles in transforming both Google and Baidu into great AI companies. It is possible for any enterprise to follow this Playbook and become a strong AI company, though these recommendations are tailored primarily for larger enterprises with a market cap/valuation from $500M to $500B.

These are the steps I recommend for transforming your enterprise with AI, which I will explain in this playbook:

1. **Execute pilot projects to gain momentum**
2. **Build an in-house AI team**
3. **Provide broad AI training**
4. **Develop an AI strategy**
5. **Develop internal and external communications**

1. Execute pilot projects to gain momentum

It is more important for your first few AI projects to succeed rather than be the most valuable AI projects. They should be meaningful enough so that the initial successes will help your company gain familiarity with AI and also convince others in the company to invest in further AI projects; they should not be so small that others would consider it trivial. The important thing is to get the flywheel spinning so that your AI team can gain momentum.

Suggested characteristics for the first few AI projects:

- It should ideally be possible for a new or external AI team (which may not have deep domain knowledge about your business) to partner with your internal teams (which have deep domain knowledge) and build AI solutions that start showing traction within 6-12 months
- The project should be technically feasible. Too many companies are still starting projects that are impossible using today's AI technology; having trusted AI engineers do due diligence on a project before kickoff will increase your conviction in its feasibility.
- Have a clearly defined and measurable objective that creates business value.

When I was leading the Google Brain team, there was significant skepticism within Google (and more broadly, around the world) of deep learning technology. To help the team gain momentum, I chose the Google Speech team as my first internal customer, and we worked closely with them to make Google Speech recognition much more accurate.

1 https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy

Speech recognition is a meaningful project within Google, but not the most important one—for example, it is less important to the company bottom line than applying AI to web search or advertising. But by making the Speech team more successful using deep learning, other teams started to gain faith in us, which enabled the Google Brain team to gain momentum.

Once other teams started to see the success of Google Speech working with Google Brain, we were able to acquire more internal customers. The team's second major internal customer was Google Maps, which used deep learning to improve the quality of map data. With two successes, I started conversations with the advertising team. Building up momentum gradually led to more and more successful AI projects. This process is a repeatable model that you can use in your company.

2. Build an in-house AI team

While outsourced partners with deep technical AI expertise can help you gain that initial momentum faster, in the long term it will be more efficient to execute some projects with an in-house AI team. Further, you will want to keep some projects within the company to build a more unique competitive advantage.

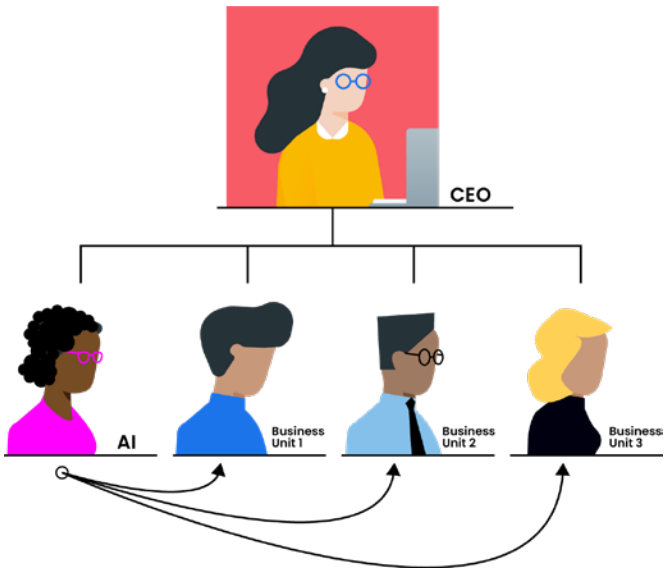
It is important to have buy-in from the C-suite to build this internal team. During the rise of the internet, hiring a CIO was a turning point for many companies to have a cohesive strategy for using the internet. In contrast, the companies that ran many independent experiments—ranging from digital marketing to data science experiments to new website launches—failed to leverage internet capabilities if these small pilot projects did not manage to scale to transform the rest of the company.

In the AI era, a key moment for many companies will again be the formation of a centralized AI team that can help the whole company. This AI team could sit under the CTO, CIO, or CDO (Chief Data Officer or Chief Digital Officer) function if they have the right skillset. It could also be led by a dedicated CAIO (Chief AI Officer).

The key responsibilities of the AI unit are:

- Build up an AI capability to support the whole company.
- Execute an initial sequence of cross-functional projects to support different divisions/business units with AI projects. After completing the initial projects, set up repeated processes to continuously deliver a sequence of valuable AI projects.
- Develop consistent standards for recruiting and retention.
- Develop company-wide platforms that are useful to multiple divisions/business units and are unlikely to be developed by an individual division. For example, consider working with the CTO/CIO/CDO to develop unified data warehousing standards.

Many companies are organized with multiple business units reporting to the CEO. With a new AI unit, you'll be able to matrix in AI talent to the different divisions to drive cross-functional projects.



New job descriptions and new team organizations will emerge. The way I now organize the work of my teams in roles like a Machine Learning Engineer, Data Engineer, Data Scientist, and AI Product Manager is different than the pre-AI era. A good AI leader will be able to advise you on setting up the right processes.

There is currently a war for AI talent, and unfortunately most companies will have a hard time hiring a Stanford AI PhD student (or perhaps even a Stanford AI undergrad). Since the talent war is largely zero-sum in the short term, working with a recruiting partner that can help you build an AI team will give you a non-trivial advantage. However, providing training to your existing team can also be a good way to create a lot of new talent in-house.

3. Provide broad AI training

No company today has enough in-house AI talent. While the media reports of high AI salaries are over-hyped (the numbers quoted in press tend to be outliers), AI talent is hard to find. Fortunately, with the rise of digital content, including MOOCs (massive open online courses) such as Coursera, ebooks, and YouTube videos, it is more cost effective than ever to train up large numbers of employees in new skills such as AI. The smart CLO (Chief Learning Officer) knows that their job is to curate, rather than create content, and then to establish processes to ensure employees complete the learning experiences.

Ten years ago, employee training meant hiring consultants to come to your office to give lectures. But this was inefficient, and the ROI was unclear. In contrast, digital content is much more affordable and also gives employees a more personalized experience. If you do have the budget to hire consultants, the in-person content should complement the online content. (This is called the "flipped classroom" pedagogy. I have found that, when implemented correctly, this results in faster learning and a more enjoyable learning experience. For example, at Stanford University, my on-campus deep learning class is taught using this form of pedagogy.) Hiring a few AI experts to deliver some in-person content can also help motivate your employees to learn these AI techniques.

AI will transform many different jobs. You should give everyone the knowledge they will need to adapt to their new roles in the AI era. Consulting with an expert will allow you to develop a customized curriculum for your team.

However, a notional education plan may look like this:

1. **Executives and senior business leaders:** (≥4 hours training)

GOAL:

Enable executives to understand what AI can do for your enterprise, begin developing AI strategy, make appropriate resource allocation decisions, and collaborate smoothly with an AI team that is supporting valuable AI projects.

CURRICULUM:

- Basic business understanding of AI including basic technology, data, and what AI can and cannot do.
- Understanding of AI's impact on corporate strategy.
- Case studies on AI applications to adjacent industries or to your specific industry.

2. **Leaders of divisions carrying out AI projects:** (≥12 hours training)

GOAL:

Division leaders should be able to set direction for AI projects, allocate resources, monitor and track progress, and make corrections as needed to ensure successful project delivery.

CURRICULUM:

- Basic business understanding of AI including basic technology, data, and what AI can and cannot do.
- Basic technical understanding of AI, including major classes of algorithms and their requirements.
- Basic understanding of the workflow and processes of AI projects, roles and responsibilities in AI teams, and management of AI team.

3. AI engineer trainees:
(≥100 hours training)

GOAL:

Newly trained AI engineers should be able to gather data, train AI models, and deliver specific AI projects.

CURRICULUM:

- Deep technical understanding of machine learning and deep learning; basic understanding of other AI tools.
- Understanding of available (open-source and other 3rd party) tools for building AI and data systems.
- Ability to implement AI teams' workflow and processes.
- Additionally: Ongoing education to keep up-to-date with evolving AI technology

4. Develop an AI strategy

An AI strategy will guide your company toward creating value while also building defensible moats. Once teams start to see the success of the initial AI projects and form a deeper understanding of AI, you will be able to identify the places where AI can create the most value and focus resources on those areas.

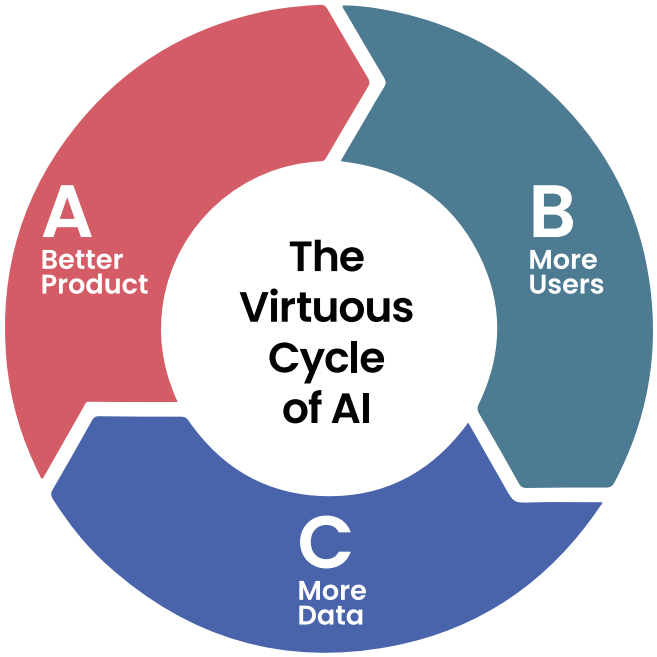
Some executives will think that developing an AI strategy should be the first step. In my experience, most companies will not be able to develop a thoughtful AI strategy until it has had some basic experience with AI, which partial progress in steps 1-3 will give you.

The way you build defensible moats is also evolving with AI. Here are some approaches to consider:

Build several difficult AI assets that are broadly aligned with a coherent strategy: AI is enabling companies to build unique competitive advantages in new ways. Michael Porter's seminal writings on business strategy show that one way to start a defensible business is to build several difficult assets that are broadly aligned with a coherent strategy. It thus becomes difficult for a competitor to replicate all of these assets simultaneously.

Leverage AI to create an advantage specific to your industry sector: Rather than trying to compete "generally" in AI with leading tech companies such as Google, I recommend instead becoming a leading AI company in your industry sector, where developing unique AI capabilities will allow you to gain a competitive advantage. How AI affects your company's strategy will be industry- and situation-specific.

Design strategies aligned with the "Virtuous Cycle of AI" positive-feedback loop: In many industries, we will see data accumulation leading to a defensible business:



For example, leading web search engines such as Google, Baidu, Bing and Yandex have a huge data asset showing them what links a user clicks on after different search queries. This data helps the companies build a more accurate search engine product (A), which in turn helps them acquire more users (B), which in turn results in their having even more user data (C). This positive feedback loop is hard for competitors to break into.

Data is a key asset for AI systems. Thus, many great AI companies also have a sophisticated data strategy. Key elements of your data strategy may include:

Strategic data acquisition: Useful AI systems can be built with anywhere from 100 data points ("small data") to 100,000,000 data points ("big data"). But having more data almost never hurts. AI teams are using very sophisticated, multi-year strategies to acquire data, and specific data acquisition strategies are industry- and situation-specific. For example, Google and Baidu both have numerous free products that do not monetize but allow them to acquire data that can be monetized elsewhere.

Unified data warehouses: If you have 50 different databases siloed under the control of 50 different VPs or divisions, it will be nearly impossible for an engineer or for AI software to get access to this data and "connect the dots." Instead, consider centralizing your data into one or at most a small number of data warehouses.

Recognize what data is valuable, and what is not: It is **not** true that having many terabytes of data automatically means an AI team will be able to create value from that data. Expecting an AI team to magically create value from a large dataset is a formula that comes with a high chance of failure, and I have tragically seen CEOs over-invest in collecting low-value data, or even acquire a company for its data only to realize the target company's many terabytes of data is not useful. Avoid this mistake by bringing an AI team in early during your process of data acquisition, and let them help you prioritize what types of data to acquire and save.

Create network effect and platform advantages: Finally, AI can also be used to build more traditional moats. For example, platforms with network effects are highly defensible businesses. They often have a natural "winner takes all" dynamic that forces companies to either grow fast or die. If AI allows you to acquire users faster than your competitors, it could be leveraged into building a moat that is defensible through platform dynamics. More broadly, you can also use AI as a key component of low cost strategy, high value, or other business strategies.

5. Develop internal and external communications

AI will affect your business significantly. To the extent that it affects your key stakeholders, you should run a communications program to ensure alignment. Here is what you should consider for each audience:

Investor Relations: Leading AI companies such as Google and Baidu are now much more valuable companies in part because of their AI capabilities and the impact that AI has on their bottom lines. Explaining a clear value creation thesis for AI in your company, describing your growing AI capabilities, and having a thoughtful AI strategy, will help investors value your company appropriately.

Government Relations: Companies in highly regulated industries (self-driving cars, healthcare) face unique challenges to stay compliant. Developing a credible, compelling AI story that explains the value and benefits your project can bring to an industry or society, is an important step in building trust and goodwill. This should be coupled with direct communication and ongoing dialogue with regulators as you rollout your project.

Customer/User Education: AI will likely bring significant benefits to your customers, so make sure the appropriate marketing and product roadmap messages are disseminated.

Talent/Recruitment: Because of the scarcity of AI talent, strong employer branding will have a significant effect on your ability to attract and retain such talent. AI engineers want to work on exciting and meaningful projects. A modest effort to showcase your initial successes can go a long way.

Internal Communications: Because AI today is still poorly understood and Artificial General Intelligence specifically has been over-hyped, there is fear, uncertainty and doubt. Many employees are also concerned about their jobs being automated by AI, though this varies widely by culture (for example, this fear appears much more in the US than in Japan). Clear internal communications both to explain AI and to address such employees' concerns will reduce any internal reluctance to adopt AI.

A historical note, important for your success

Understanding how the internet transformed industries is useful for navigating the rise of AI. There is a mistake that many businesses made navigating the rise of the internet that I hope you will avoid as you navigate the rise of AI.

We learned in the internet era that:

Shopping Mall + Website ≠ internet company

Even if a shopping mall built a website and sold things on a website, that by itself did not turn the shopping mall into a true internet company. What defines a true internet company is: Have you organized your company to do the things that the internet lets you do really well?

For example, internet companies engage in pervasive A/B testing, in which we routinely launch two versions of a website and measure which works better. An internet company may even have hundreds of experiments running at the same time; this is very hard to do with a physical shopping mall. Internet companies can also ship a new product every week and thus learn much faster than a shopping mall that might update its design only once per quarter. Internet companies have unique job descriptions for roles such as product manager and software engineer, and those jobs have unique workflows and processes for how they work together.

Deep learning, one of the fastest growing areas of AI, is showing parallels to the rise of the internet. Today, we find that:

Any typical company + Deep Learning technology ≠ AI company

For your company to become great at AI, you will have to organize your company to do the things that AI lets you do really well.

For your company to be great at AI, you must have:

Resources to systematically execute on multiple valuable AI projects: AI companies have the outsourced and/or in-house technology and talent to systematically execute on multiple AI projects that deliver direct value to the business.

Sufficient understanding of AI: There should be general understanding of AI, with appropriate processes in place to systematically identify and select valuable AI projects to work on.

Strategic direction: The company's strategy is broadly aligned to succeed in an AI-powered future.

Turning your great company into a great AI company is challenging but feasible with the support of great partners. My team at DeepLearning AI is committed to helping partners with their AI transformations, and I will continue to share additional best practices.

An AI Transformation program may take 2-3 years, but you should expect to see initial concrete results within 6-12 months. By investing in an AI transformation, you will stay ahead of your competitors and leverage AI capabilities to significantly advance your company.

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