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# Using Big Data to Improve User Experience across the Enterprise

Our single user experience framework is providing significant insights toward delivering seamless integration and is speeding the transformation of user experience.

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### Executive Overview

Intel IT set a goal of defining and implementing a single user experience framework as a standard for all enterprise solutions. We developed a holistic understanding of the enterprise experience and then provided a model for other IT teams to emulate when developing products and tools.

The framework is a conceptual map of the desired user experience, using large-scale, layered storytelling. Stories are composed of experience themes (such as finding information, connecting with people, and remembering user information), user segments based on needs and goals, influences on these segments, and the activities necessary to achieve those goals. While each story focuses on a single experience, collectively these stories encompass the enterprise experience.

The experience framework provides a model of reusable insights and templates that IT teams can quickly adapt and insert into existing processes. By creating common target experiences and identifying shared priorities we can create efficiencies across enterprise services and portfolios.

We targeted the following project goals:

- **Productivity.** Increase employee productivity by at least 25 percent.
- **Adoption.** Achieve 100 percent adoption of IT solutions.

We also identified a need for a single repository of data, both quantitative and qualitative, that human factors engineers and IT professionals could use to continuously analyze user behavior.

To build, create, and refine our framework, IT needed usage data. Standard user experience research methods often produce data that is unstructured and not statistically relevant, while raw usage data can be voluminous, lack context, and may have privacy issues. We combined traditional user experience research techniques with de-identification and big data approaches to provide our framework with a data repository that meets privacy standards and provides insight into the framework effectiveness. As a result, our single user experience framework is providing significant insights toward delivering seamless integration and is speeding the transformation of user experience.

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## Acronyms

- ETL** extract, transform, load  
**PoC** proof of concept  
**UX** user experience

# Background

Businesses use a variety of products to manage the daily flow of employee communications and transactions. From submitting expense reports to collaborating with peers, employees interact with many interfaces, platforms, and devices every day. Switching between these products and platforms often requires users to enter redundant information about themselves or their work, and it is often left up to them to make sense of conflicting user interfaces, which can lead to frustration and inefficiency.

At the same time, consumerization of IT outside the enterprise presents employees with easy-to-use devices with integrated applications that perform many different tasks. This creates high expectations for similar ease of use in enterprise tools.

IT departments understand the importance of refining the user experience (UX) to improve productivity and increase the speed at which work is completed. However, UX professionals often focus on specific systems, overlooking the broader need to standardize and unify the enterprise experience.

To work toward a standard for all our enterprise solutions, Intel IT set out in 2011 to define and implement a single user experience vision and architecture. This initiative called for ongoing analysis of user behavior to ensure that the framework remained relevant over time.

## Goals

We wanted to develop a holistic understanding of the enterprise experience and then provide a model for other IT teams to emulate when developing products and tools (see Figure 1). This approach required that UX and IT professionals across the enterprise use a single experience framework to facilitate discussions about the UX.

We defined the following measures of success:

- **Productivity.** Increase employee productivity by at least 25 percent.
- **Adoption.** Achieve 100 percent adoption of IT solutions.

We also identified a need for a single repository of data, both quantitative and qualitative, that human factors engineers and IT professionals could use to continuously analyze user behavior.

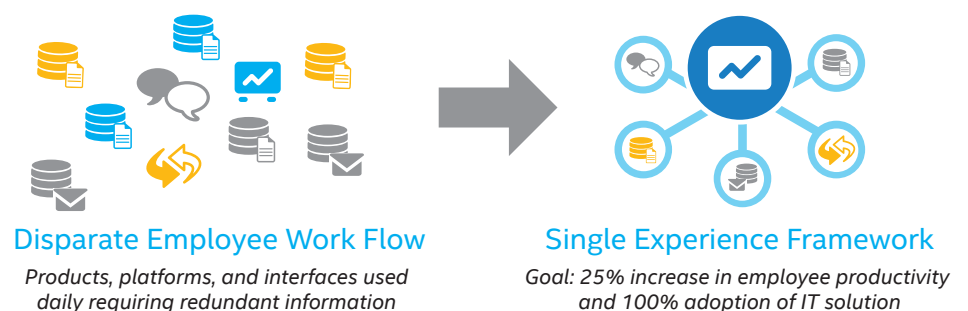


Figure 1. Our goal was to develop a holistic understanding of the enterprise experience and provide a model for other IT teams to emulate.

## Challenges

To understand the current IT experience, we needed to consolidate data from traditional UX research data stored in silos across the enterprise.

These data sources had particular properties and issues:

- **Issues with big data.** Enterprise operations generate byproduct data, such as transactions, support tickets, and social metadata, which can provide rich details about user behavior. But this data does not tell us what motivates that behavior or how that behavior fits into the larger context of enterprise productivity. This data also often contains employees' personal information, carrying the potential of violating user privacy.
- **Issues with UX information.** Traditional UX research methods provide contextual insights by relying on small numbers of user narratives and observations from interviews, design sessions, social media, and open-ended comments on surveys. This information is qualitative and can help provide a richer understanding of the holistic experience as well as behavioral motivation. But the information is unstructured, and the sample sizes are limited and often do not provide a statistically relevant example.

We needed to develop a single repository that housed content from big data sources as well as UX information across the enterprise that could be used for ongoing usability research. The data also needed to be de-identified before it was made available to researchers.

## Solution Design

Developing and implementing a single UX framework required connecting disparate data sources that spanned more than 100,000 employees, 700 hours of user narratives, 20,000 survey responses, and 18 million system transactions, while simultaneously protecting employee privacy. We first describe how we aggregated and analyzed the data, and then we describe how we protect employee privacy.

### Data Aggregation and Analysis

Identifying and collecting the enterprise data yielded a mix of structured and unstructured data in formats that were sometimes undocumented and often inconsistent within and between datasets. Formatting also sometimes changes over time, resulting in inconsistencies within single datasets.

Unstructured data, such as the content found on social media platforms and blogs, and other textual information is rich in insights but difficult to make sense of in its raw form. We realized that we needed to acquire new skill sets to aggregate this data, which we did by providing additional training to team members and building new partnerships with data architects and developers in the larger IT organization.



## Connecting Disparate Data Sources

For more information on developing and implementing a single UX framework, see these publications:

- McCreary, F., A. McEwan, D. Schloss, and M. Gomez. "Envisioning a New Future for the Enterprise with a Big Data Experience Framework." *New Perspectives in Information Systems and Technologies, Volume 1*. Springer International Publishing, 2014. 199–209.
- McCreary, F., M. Gómez, D. Schloss, and D. Ali. "Charting a New Course for the Workplace with an Experience Framework." *HCI in Business: First International Conference, HCIB 2014, Held as Part of HCI International 2014, Heraklion, Crete, Greece, June 22-27, 2014*. Proceedings. Springer International Publishing, 2014.

## Examples of User Experience Data

- Employee Information
- Compute Assets
- Mobile Profiles
- Technical Support Tickets
- Employee Support Tickets
- Employee Portal
- Patching and Compliance
- Expense Reports
- Learning System
- Subscription Learning
- Social Platform
- Recognition
- Surveys

Data aggregation included the following activities:

- **Reconcile formats.** Whenever possible, we used ETL (extract, transform, load) processes to bring structured data into the repository. In other cases, we converted the data to flat files for upload.
- **Summarize variables.** We distilled specific variables into meaningful summary data, making downstream analysis easier, such as consolidating individual support tickets into the total number of tickets and the mean time between tickets by user.
- **Develop text analytics.** Using the Cloudera Distribution for Apache Hadoop\* linked with text analysis tools, we analyzed qualitative data for pattern recognition, sentiment analysis, and visualization. This analysis also provided predictive capabilities to understand common searches and terminologies—to determine search relevance. With predictive search capabilities, we can provide users with close approximations of what they are looking for based on collective search data.
- **Code UX narratives.** We built coding structures to address unstructured narrative content by identifying specific attributes in the workflow (such as steps, triggers, and decision points), critical incidents, environmental factors, social connections, underlying technology, and individual characteristics (such as attitudes and motivators).

We distilled all this data into individual usage footprints, using coded identifiers to de-identify users. By organizing data by users, we could better discern individual patterns and integrate new quantitative information as it was discovered. The architecture of our configuration and flow of data to discern the patterns are shown in Figure 2.

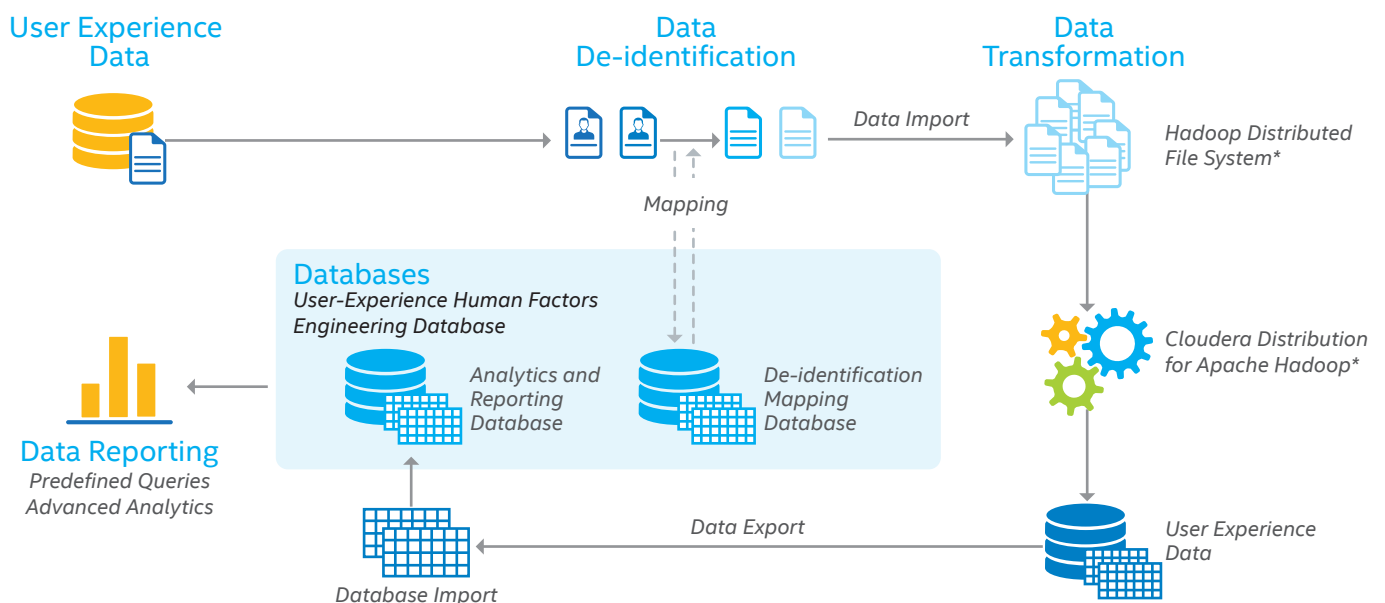


Figure 2. The user-experience architecture connects enterprise data with user-experience data in a single repository for ongoing analysis. Data is de-identified prior to collection in the repository to protect employee information.

## Addressing Privacy Concerns

To protect employees' privacy when storing data in the cloud or using it for analysis, we first de-identified the data by removing personal information such as IP address and username. We had previously speculated about the process of de-identification<sup>1</sup> and had some initial security concerns, based on existing literature, about the use of de-identification techniques and the usefulness of the resulting data. However, our experience with enterprise data and our ability to secure it, as opposed to public data, proved successful.<sup>2</sup>

Using our internal web portal as a test case, we developed a proof of concept (PoC) de-identification architecture that encrypted log data, stored it in the Hadoop Distributed File System\*, and then served query answers to a secure enclave through symmetric key encryption (see Figure 3).

We chose symmetric key encryption because it allows multiple tools to work on the data. A set of tools can generate and read the same data as long as they use the same key and encryption mode. We adapted the metrics used in the medical industry for protecting patient records:

- **Average risk.** This is the average of all the exposure probabilities. It provides a broad measure of disclosure risk.
- **Maximum risk.** This is the highest risk of any disclosure probability. It represents the maximum risk to any individual whose behavior is recorded in the dataset.

Many fields in the dataset could be used (through correlation) to identify the individual user, such as site code, time zone, and user language. Our PoC testing revealed areas of vulnerability, and we made the following changes to the log file that greatly improved the quality of de-identification and its resistance to attack:

- **References.** We removed all sites, nodes, languages, and other characteristics associated with the individual.
- **Agent/Browser.** We removed the user agent/browser information.
- **Time stamps.** We aggregated time stamps with increasingly larger intervals of data.
- **Entries.** We removed entire log entries that carried a high risk of disclosure.

Once we validated that the de-identification process met our security requirements in the PoC, the data was added to the framework shown in Figure 2. For the coded identifiers, we decided to use a scrambled version of identifiers rather than symmetric key encryption for performance and ease of coding.

<sup>1</sup> For more information on de-identification, see the IT@Intel white paper "Enhancing Cloud Security Using Data Anonymization."

<sup>2</sup> Sedayao, J., R. Bhardwaj, and N. Gorade. "Making Big Data, Privacy, and Anonymization Work Together in the Enterprise: Experiences and Issues. 2014 IEEE International Congress on Big Data (BigData 2014). IEEE, 2014.

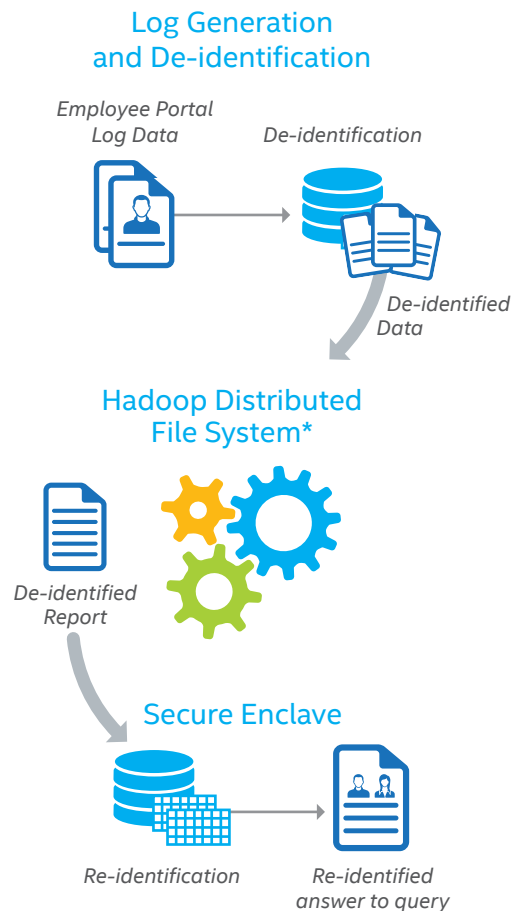


Figure 3. De-identification (and re-identification if required) takes place in a secure enclave. Data analysts have access to the de-identified data in the Hadoop Distributed File System\*, protecting personal information.

## User Experience Design

We created a single UX framework standard for all enterprise solutions by connecting enterprise transactional data with the output from traditional UX methods. To facilitate the product teams' ability to use the framework, we introduced user scenarios. These stories outline the individual goals that employees needed to achieve, such as finding information, connecting with people, or updating information. The stories focus on particular elements of the dataset. When viewed collectively, these stories map the entire enterprise experience. IT teams use these stories and data to create their own stories relevant to their specific product.

The framework includes four elements that provide insights for IT systems builders.

- **Themes** define the enterprise experience vision that spans the many products and services provided, such as how users find information. The themes were:
  - Feed me - finding information
  - Connect me - connecting with people
  - Know me - remembering user information

Table 1 lists the qualities that represent each of the three themes.

- **Segments** define the user groups, such as hardware technologists or software developers, to consider when creating the experience and provide a base for personas. The personas include goals and needs, key tasks and behaviors, pain points, use of enterprise products, and relative priority for each segment.

Table 2 provides an example of how we have broken out employee segments and focus.

Table 1. Themes and qualities. Themes identify the core need, and qualities represent how that need should be fulfilled.

Theme	Qualities
<b>Feed Me</b>	I can quickly and easily find the information I need: <ul style="list-style-type: none"> <li>• Seamless – transparent, integrated, flexible</li> <li>• Simple – quick, easy, understandable</li> <li>• Meaningful – relevant, timely, informative</li> <li>• Proactive – automatic notification</li> </ul>
<b>Connect Me</b>	I am connected to the people, resources, and expertise I need for success: <ul style="list-style-type: none"> <li>• Purposeful – work together</li> <li>• Easy – always connected</li> <li>• Cooperative – supportive environment</li> <li>• Presence – always available</li> </ul>
<b>Know Me</b>	I am known, but my information is protected: <ul style="list-style-type: none"> <li>• Recognized – information is stored</li> <li>• Personalized – role and needs are known</li> <li>• Customized – choices are provided</li> <li>• Private – personal information is protected and secure</li> </ul>

Table 2. Segments represent groups of users and their areas of shared focus.

Segment	Shared Focus	Subsegments
<b>Hardware Technologists</b>	Identifying hardware at various stages of the product lifecycle	<ul style="list-style-type: none"> <li>• Factory engineer</li> <li>• Product engineer</li> <li>• Sales engineer</li> <li>• IT engineer</li> </ul>
<b>New Employees</b>	Learning about the corporation while doing their individual jobs	None
<b>Manufacturing Operations</b>	Meeting production schedules, including translations	None
<b>Area Experts</b>	Applying their skills to various employee segments	<ul style="list-style-type: none"> <li>• Leads</li> <li>• Analysts</li> <li>• Sellers</li> <li>• Corporate curators</li> </ul>
<b>Software Developers</b>	Developing software for various audiences	<ul style="list-style-type: none"> <li>• Product developers</li> <li>• IT developers</li> </ul>
<b>Administrators</b>	Advocating for the success of others	None

- **Influencers** are core elements of the enterprise, such as IT, HR, and the physical workplace. They help product teams assess the relative contribution on the holistic enterprise experience.
- **Activities** help IT understand its impact on the overall experience. Activities are the specifics of how employees interact with the enterprise to accomplish shared tasks.

The experience framework is a representation of the desired future of the enterprise from the user perspective. It provides a model for IT teams who are delivering products and services daily. Success depends on the adoption of this shared vision as well as a new shared vocabulary and methods. Data de-identification, aggregation, and analysis keep the framework relevant.

## Implementation

The success of our project depended on gaining the commitment of the people tasked with implementing it. UX professionals make up a small percentage of our IT organization, and we retain a traditional IT staffing model. While some IT staff already have a good understanding of UX principles and tools, most have limited experience.

Our challenge was to create an environment in which the value of the framework was agreed on, determine integration intervals, and validate with data. The design in Figure 2 was implemented by a big data/analytics specialist along with Intel's IT Graduate Program resources (see Agile Development and Intel's IT College Graduate Program).

### Agile Development and Intel's IT College Graduate Program

We decreased our development time on this project by approximately 50 percent by taking advantage of Intel's newly created IT College Graduate Program. The IT College Graduate Program, now in its second year, offers a pool of Intel employees who are recent graduates a chance to gain work experience. By rotating onto projects that require additional resources for a limited time, these graduates can contribute to the success of a variety of initiatives throughout the enterprise while exploring areas of personal interest.

Without the IT College Graduate Program, we might have had to hire contractors or lengthen the overall development time. By using internal resources instead of contractors, we have also retained the core project knowledge within the enterprise after the project ends.

We used Agile as our development process, enabling us to further speed the overall delivery by assigning lower priority but essential areas of focus to resources dedicated to other projects. This method takes advantage of the naturally occurring available time that dedicated resources experience.



## The Experience Framework

For more information about the experience framework, see these publications:

- McCreary, F., A. McEwan, D. Schloss, and M. Gomez. "Envisioning a New Future for the Enterprise with a Big Data Experience Framework." *New Perspectives in Information Systems and Technologies, Volume 1*. Springer International Publishing, 2014. 199–209.
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IT staff who can take advantage of the framework

Table 3. The experience evaluation tool illustrates where the current user experience for a particular solution is out of sync with the requirements, showing where IT teams should focus user experience activities.

Theme	Quality	Score
Feed Me	Seamless	50%
	Simple	50%
	Meaningful	50%
	Proactive	10%
	<b>OVERALL</b>	<b>10%</b>
Connect Me	Purposeful	50%
	Easy	50%
	Cooperative	50%
	Presence	50%
	<b>OVERALL</b>	<b>50%</b>
Know Me	Recognized	75%
	Personalized	75%
	Customized	75%
	Private	75%
	<b>OVERALL</b>	<b>75%</b>
<b>OVERALL SCORE</b>		<b>54%</b>

Share:

## Applying the Framework

The new framework provided reusable insights and templates that teams could quickly adapt and insert into existing processes. This outcome directly benefited each project by decreasing the development lifecycle time. Also, by providing common target experiences and shared priorities, we helped create efficiencies across enterprise services and portfolios.

We approached the introduction of the framework by first creating an awareness of its benefits. We publicized it through our social collaboration platform, workshops, and training to targeted IT staff by groups. Sixty percent of our IT staff—those with the greatest opportunity to influence the experience—can now take advantage of the framework.

To help guide IT professionals in incorporating the framework, we proposed the following iterative approach using the framework tools:

1. **Evaluate the current state.** Use the defined segments to understand users and themes, and to determine how well current products and services are meeting the needs of employees.
2. **Ask “What if?”** Use the relevant theme components to discuss new possibilities with users, stakeholders, and teams.
3. **Prioritize what is most needed.** Combine the objectives of our UX framework with the output of steps 1 and 2 to define a UX strategy, including roadmaps and identified gaps.
4. **Define the detail.** Use the framework personas, requirements, scenarios, and related design patterns to define what the new product or service should do.

We stressed that the framework insights did not replace existing UX findings, but instead provided additional information. We clarified that the framework would not answer all their questions and that gaps in understanding should be filled through traditional UX methods.

## Experience Evaluation Tool

To evaluate how well the existing experience aligned with the experience envisioned by the users, we developed an experience evaluation tool. By checking off the high-level requirements relative to the existing experience, teams could quickly see how well the current solution aligned with the themes. The result was a score and color-coded heat map (see Table 3) that showed teams where they should focus more attention in order to improve the UX.

In Table 3, Know Me tasks, which recognize employees without requiring them to enter information, are on target. Connect Me tasks, which put employees in touch with others who may have relevant information, have some usability challenges. Feed Me tasks—information employees routinely seek—have significant usability challenges.

The heat map also served as an evaluation tool for vendor selection and as a design foundation for new products and the evolution of existing ones.



## Results

The introduction of themes, such as how employees find information, is shifting the way IT thinks about the UX. Product roadmaps track alignment with the themes, and user functionality is driving roadmap timing. Our multiyear plans now include experience services that focus on more efficiently delivering the integrated experience that employees want and need.

### Use Cases

We tested the experience platform and UX repository in three areas with promising results:

- **Features for the internal social platform.** We merged data usage patterns from the existing platform, support tickets, and internal portal with qualitative insights from traditional UX methods to define a baseline set of requirements and desired features. The data played an important role in determining a new social platform, which has since been implemented.
- **Hotspots on the enterprise capability framework.**<sup>3</sup> The enterprise capability framework provides a holistic view of the enterprise and the key functions performed, such as manufacturing and design, which align to the supply chain. With this framework we can map transactional data against the services and portfolios to address issues more quickly and design better solutions for the enterprise.

We combined support data, common search terms, application profile data, and user demographics with traditional UX methods to identify potential connections between various segments of our business-facing IT groups and IT services. Our goal was to understand how various portions of the IT organization aligned and what services might potentially disrupt business processes. We continue to work in this area, and we plan to create a visual representation of impacts by business area that may require attention.

- **Target audiences for communication, PoCs, or studies.** In combining transactional data with big data techniques, we created analytical models based on particular usage characteristics. We can now target specific user populations for relevant communications or for participation in technology evaluations. The experience framework has allowed us to cover a specific audience or a broad range of user types with no negative impact to user productivity while returning useful feedback. We experienced higher confidence that we were gathering more meaningful, more representative survey data by targeting smaller audiences.

### Agile Teams

Agile teams have found that **segments** and experience **elements** are the most useful for generating starting presumptions. On Agile projects, the rich detail provided by the framework helps bring focus to the team, and helps the team move more rapidly from concept to prototype. In multiple projects, this information has served as a catalyst for creating design hypotheses around presumptions of what features and capabilities should be included in the solution. From the created design hypotheses, a series of user scenarios are written, which are then used to create storyboards of the product vision. The framework examples often inspire prototype designs, and the storyboards typically map to themes.

<sup>3</sup> For more information, see the IT@Intel white paper "Optimizing the Value of Technology Investments with IT Strategic Planning."

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The rich data available on individuals, job roles, organizations, and geographic locations makes available many more stories than we currently have identified.

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## Challenges Ahead

Discovering great experience solutions is as much about collecting and analyzing data as it is about transforming an organization to use that data effectively. It is a collaborative process that requires joint participation and extensive collaboration.

We identified the following challenges to address as we further integrate the experience framework in our development activities:

- **Make the story consumable.** The size of our dataset has made it difficult to keep the UX story easy to use and understand. Even with the wide range of tools that we created for the experience platform, teams can still find the framework unwieldy to learn. Newcomers to the process easily lose their way in the multilayered story. We must continually work directly with teams to help them understand the framework.
- **Manage the increasing amount of data.** Since its introduction, the underlying dataset has nearly tripled, and it is expected to grow even more rapidly in the coming years. We have incorporated only about 30 percent of the available user transactional data in the framework, further challenging comprehension of behaviors at the holistic level by project teams.
- **Enable social storytelling.** Today, storytelling using the experience framework is limited to the research team that produced the framework or UX professionals working directly with them. The rich data available on individuals, job roles, organizations, and geographic locations makes available many more stories than we currently have identified. The lack of self-service environments, though, limits the framework's broader use.
- **Continuing the transformation.** Every team or individual starts from a different point of understanding of what effective UX is and how to implement it. We have all had to transform our thinking, approach, decisions, and actions regarding the way we do research from our individual perspectives to the broader enterprise strategy. It is a journey that continues.

## Key Learnings

The UX framework is being used across the enterprise to improve our UX strategy, technical architecture, and product design. As a result, we have learned the following about how to more effectively integrate portfolio strategy and design:

- **Begin with qualities.** When teams began using the framework, qualities provided the baseline for improvement. The experience qualities were also invaluable for setting vision and strategy. The qualities sparked conversations and provided functionality checklists.
- **Understand elements early.** Product teams found that they needed experience elements that provided user requirements, scenarios, and key audience differences before they could move from strategy to design.
- **Use sample designs for new ideas.** Sample designs that embodied the experience themes and elements sparked new ideas and conversations about how to improve products and services.
- **Use iteration to overcome roadblocks.** Different learning styles sometimes made the experience framework materials less effective. In these instances, iterating as

### 5 Ways to More Effectively Integrate Portfolio Strategy and Design

1. Begin with qualities
2. Understand elements
3. Use sample designs
4. Use iteration
5. Print hardcopies

many times as necessary was the key to overcoming the obstacles and aligning with the framework.

- **Create hardcopies.** Generating designs went more quickly when teams printed the materials, such as elements and themes, so participants could reuse them during discussions and prototyping.

We discovered creative ways to use big data beyond its original role in the framework. By intersecting the broader user data with data specific to a product or service, we discovered new insights about how our users expected the products to align with the overall experience. Teams gained a better understanding of how their users utilize other enterprise products, as well as their preferences, making it easier to align the products to the UX vision.

## Conclusion

The UX framework has provided significant insights into what Intel employees need. In a world where businesses are constantly expected to move faster and employees become increasingly sophisticated in their expectations of technology, the experience framework has helped to speed up the UX transformation. By aggregating big data with the outputs from traditional UX research while addressing privacy concerns, we have taken steps toward a greater UX in the enterprise.

Presenting big data through user stories helps us understand whether our insight from qualitative studies can be applied to larger groups of business users. Through the use of segments, and subsequently personas, we can also make big data more accessible. The experience framework defines interaction norms across enterprise tools and services to help developers create better interfaces. A common language results in more product team discussions that generate strategy and design ideas faster.

Transformation is a participatory process. For change to happen, all levels of the organization must participate in the conversation and take ownership of how their own role impacts the enterprise experience. A fully realized experience framework can be the impetus to a shared vision that significantly improves the business UX.

For more information on Intel IT best practices, visit [www.intel.com/IT](http://www.intel.com/IT).

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