Design Research in the Context of Federal Law Enforcement

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Abstract - In recent years, design thinking and design research have proved indispensable in creating useful and usable solutions that both address human needs and create value for the client. Design research is the connective activity that helps us integrate specialized knowledge into meaningful solutions. We used a structured design process and various design research methods to facilitate the design and development of a software and hardware solution for a federal law enforcement agency to automate and standardize the processing and collection of a certain type of evidence. The methods we used were crucial in gathering the necessary evidence and presenting a synthesized, meaningful picture of the problems at hand to the client. This in turn led to a highly effective and collaborative partnership that resulted in a high-value application that helped standardize the current state of practice and advanced the mission of the federal law enforcement agency in the realm of intelligence gathering.

Index Terms – Design research, designing for federal law enforcement, human-centered design

INTRODUCTION

In recent years, design thinking and design research has proved indispensable in creating useful and usable solutions that both address human needs and create value for the client. Many products and services we currently create rely on specialized knowledge that is clearly documented and defined. However, this knowledge is "fragmented into so great an array of specializations that we cannot find connections and integrations that serve human beings either in their desire to know and understand the world or in their ability to act knowledgeably and responsibly in practical life" [1]. This is where design research becomes particularly helpful. As the connective activity that integrates knowledge from many fields, design research is universal in scope as it facilitates the "conceiving, planning and making of products that serve human beings in the accomplishment of their individual and collective purposes" [1].

Design research in professional practice relies on methods and approaches derived from a wide range of disciplines, including social and behavior sciences, business, and marketing [2]; however, the differentiating factor is that when applied within the design process, these methods yield deliverables that are "significantly visual" and exhibit a "delight factor" [3]. Design research methods can be loosely categorized into three areas, based on what they help us accomplish. From the exploratory perspective, there are methods that help us understand people and their behaviors, perceptions, experiences, needs, and desires that help us develop empathy for the future users of the product. From the generative perspective, design research provides methods for effective development of new ideas and concepts, leading to innovation. Finally, from the evaluative perspective, design research encompasses methods that help us systematically test products for their usability, usefulness, and desirability. Collectively, these methods enable effective collection of data, its analysis and subsequent synthesis into actionable design implications. As such, the activity of design research creates knowledge that facilitates structured and productive conversations [4] among members of interdisciplinary teams as well as with the client and builds credibility of the entire design process. This collaborative process and the exchange of newly created knowledge lead to meaningful products.

Our organization's ultimate goal is to create cutting-edge solutions customized to the needs of government employees. While doing design research is often challenging, working with federal government clients presents a unique set of challenges because of the laws and regulations that affect our access to data and target audiences, access that design research cannot occur without. This challenge is even more exacerbated when creating solutions for federal law enforcement agencies in the realm of cybersecurity and digital intelligence.

978-1-4799-3749-3/14/$31.00 ©2014 IEEE

Primarily due to the sensitivity of data this domain encompasses, we must tackle the restricted physical access to people and places as well as the use and dissemination of information that stems from the gathered data.

In this report, we present the structured process and design research methods we utilized to design and develop a software and hardware solution for a federal law enforcement agency. Combining a desktop application, high-speed scanner, and OCR technology, this solution automated and standardized the processing and collection of a certain type of evidence.

THE DESIGN PROCESS

To design and develop the evidence processing application that would improve the state of practice for paper-based evidence processing using OCR technology, the team went through five process stages:

- Research
- Synthesis
- Concept Development
- Implementation
- Transition

Each of these stages utilized various design research methods. Fig 1 gives an overview of that process and lists the design and software methods that were executed by the team.

RESEARCH

We began the project by doing secondary research, an activity that consists of collecting and synthesizing information from existing data, rather than creating original material through primary research with participants [4 pp.154]. We collected publicly available information about the client, the particular division of the agency and the type of evidence to be processed to gain basic insight into the product context and to help us define the design research direction we would take.

Simultaneously, we began working on an informal literature review, which is a well-known method of academic research, but is also very useful for design teams to collect and "distill information from published sources on previous research or projects as they might inform the current project" [4 pp.112]. We reviewed and analyzed pertinent agency documentation including training materials, directives, policies, and evidence reports and assessed current solutions of scanning and OCR-ing evidence.

.Needing to understand our future users, their environment and current processes, we conducted six contextual inquiries at five federal law enforcement field offices. Collectively, this sampling exemplified light, medium, and heavy processing and investigative activity, which enabled us to get the most complete picture possible. Contextual inquiry "is an immersive contextual method of observing and interviewing that reveals underlying (and invisible) work structure" [4 pp.46]. To reveal this structure, including the various communication flows and task sequences, we participated in the future users' work environment and assumed the role of an apprentice, inquiring about and documenting the activities and artifacts the analysts used to accomplish their tasks. Over the course of two hours for each inquiry, we were not only able to learn first-hand about the current methodology of processing paper-based evidence, we were also able to steer the interaction toward topics that

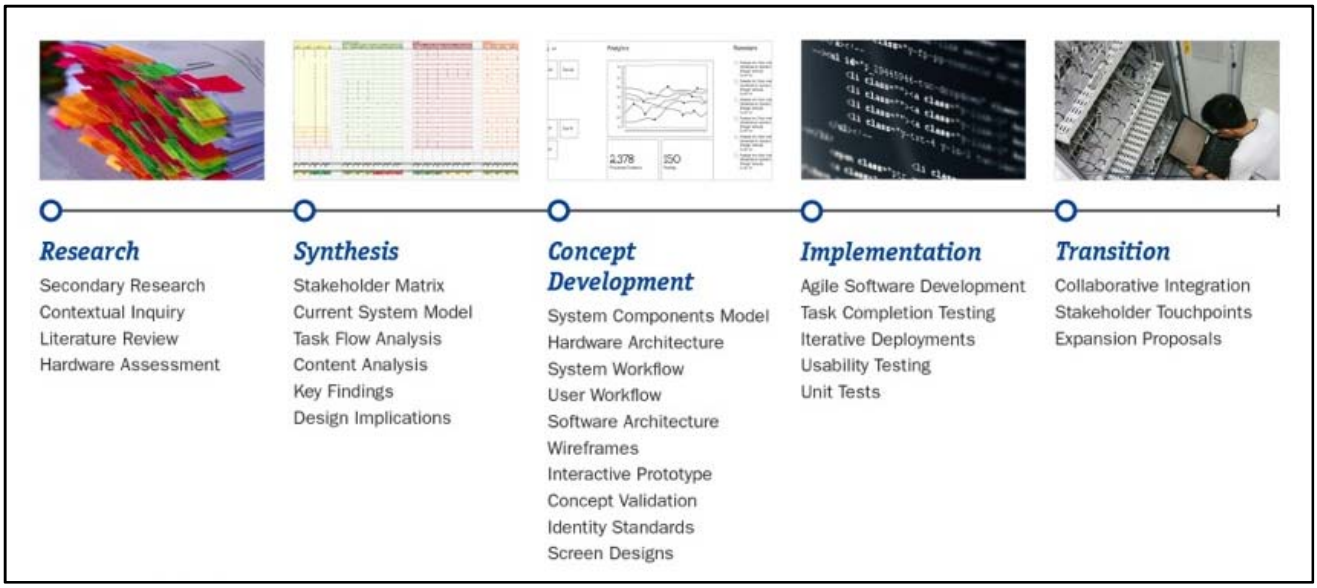

FIGURE 1. OVERVIEW OF DESIGN AND DEVELOPMENT STAGES LISTING THE METHODS UTILIZED.

were relevant to the project scope and directly verify our interpretations of our observations in the context of the future solution. Having two researchers conduct one inquiry allowed us to effectively interact with the participant (first researcher) and document the information (second researcher). This partnership afforded us the opportunity to later discuss the various observations, leading to a more objective interpretation of the research.

Thanks to this method, we were able to tap into the mass of undocumented tacit knowledge the analysts possessed about the process without even knowing it. Having done multiple contextual inquiries, we were able to compare and synthesize the data to identify the patterns of behaviors, communication flows, situations, and artifacts, or their lack of. The synthesis of all contextual inquiries yielded highly reliable and valuable information that served as the basis for improving the ways paper-based evidence would be processed using the new software solution.

SYNTHESIS

To synthesize the information, we utilized a range of design research methods. First, to document the various participants and their responsibilities within the processing and investigative process, we created a stakeholder responsibility matrix. Mapping the responsibilities allowed us to better understand their varying roles and needs for the new solution and, as a result, identify the primary user of the future system. To fully understand the primary user's current sequence of tasks, we utilized the task analysis method, which "breaks down the constituent elements of a user's work flow, including actions and interactions, system response, and environmental context" [4 pp.174]. Synthesizing the observed process from six contextual inquiries, we began to see the similarities and differences. Using color-coding within the task analysis model, we marked observed steps in grey, discrepancies between observed and documented behavior in blue and expressed or observed pain points (opportunities for improvement) in red. Finally, to analyze the communication and data flows among the various elements of the observed system, we created a comprehensive system model that visualized the interactions, connections, and breakdowns among the actors, artifacts, and technology.

I. Key Findings

Our synthesis revealed that across the multiple field offices, there was a lack of automation that caused delays and breakdowns within the entire process. Manual processing of evidence and entry of information proved to be very tedious. It also allowed for human error and led to purposeful omission of information in an effort to speed up the process. Our research also revealed that the amount of evidence and related information is overwhelming, further exacerbating the already significant delays in processing. All these factors hindered timely intelligence gathering. Distribution of records among actors and disparate systems prevented pattern identification that is vital for investigations. Furthermore, we found out that the current software solution did not map well to the processing workflow, causing duplication, omission of information and evidence misidentification. Lastly, our research revealed that currently used taxonomy and terminology are confusing and vary across field offices.

II. Design Implications

Based on the key findings, we defined the major design implications and goals for the future solution:

- Integrate with existing systems and databases to close the information gap.
- Use high-speed scanners to automate the intake of evidence and related information.
- Use OCR technology to provide efficient, complete, and accurate records.
- Provide contextual information about existing and new evidence to aid in intelligence gathering and pattern identification.
- Provide a unified methodology to help standardize processing.

CONCEPT DEVELOPMENT

Having a clearly defined design direction allowed us to begin developing a new approach to processing paper-based evidence. We began by visualizing the new system components into a model.

Knowing all the elements of the new system, we could start defining the overall system stages and the individual steps a user would take to process the evidence using the new software and hardware solution. We again used the task analysis method; however, this time we were not synthesizing collected data. Instead, we were collectively defining new workflows through individually generated ideas and concepts and visualizing it into two sets of models: system workflows (see Fig. 2) and user workflows (see Fig. 3). Through the use of icons and color we created the hierarchical relationship of the two types of models. By collaboratively identifying a step-by-step approach that incorporated all design implications, we began to extract specific software and hardware requirements needed to successfully process evidence, input all necessary related information, all the while maintaining the chain of custody as well as the authenticity and integrity of evidence.

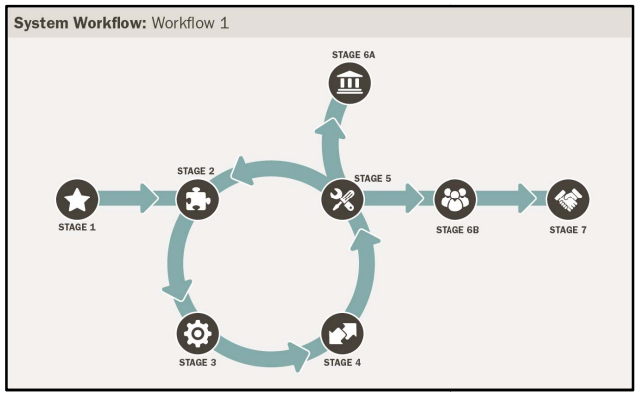

FIGURE 2. ABSTRACTED SYSTEM WORKFLOW EXAMPLE.

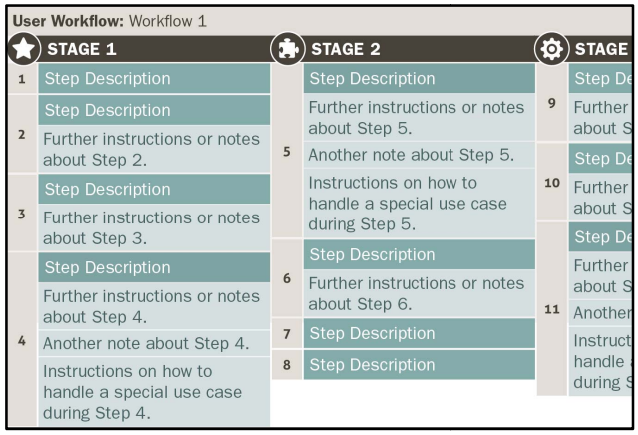

FIGURE 3. A CROPPED VIEW OF AN ABSTRACTED USER WORKFLOW ILLUSTRATING ITS STRUCTURE.

Once new system and user workflows were established, we were able to create wireframes (see Fig. 4) to establish the core functionality, interactions and content hierarchy to meet the identified requirements in the form of a graphical user interface of the new desktop application.

The first iteration of the mid-fidelity wireframes was shared with the client and enabled us to have a productive and structured conversation to confirm the overall direction of the project and validate high-level requirements through a concrete representation of the future solution.

To validate the concept with future users as well, we created another iteration of wireframes, this time in much higher fidelity. During this stage, we faced the challenges of limited time, restricted physical access to future users and the inability to deploy a prototype on user machines for testing due to the internal software policy of the federal law enforcement agency. Since these factors prevented us from validating the concept through the usual evaluative design research methods such as think aloud protocol or remote moderated research, we came up with our own evaluative method. Combining wireframes, task completion analysis, usability testing and a survey, we created an interactive PDF structured into four sections:

- **Workflow:** We asked the participants to review three new workflows, validate individual steps, and identify any breakdowns.
- **User Interface:** We showed the participants the visual mockups, presented them with a short scenario, and asked them how they would complete 19 simple tasks.
- **Concept**: We asked the participants to rate the overall system concept based on 10 criteria and whether they thought the new system would help with their daily responsibilities.
- **Experience:** We asked the participants seven open-ended questions about the overall experience with the system and its potential.

Using a teleconference, we held a testing session with 27 participants from 24 field offices and guided them through the testing activities, asking them to record their

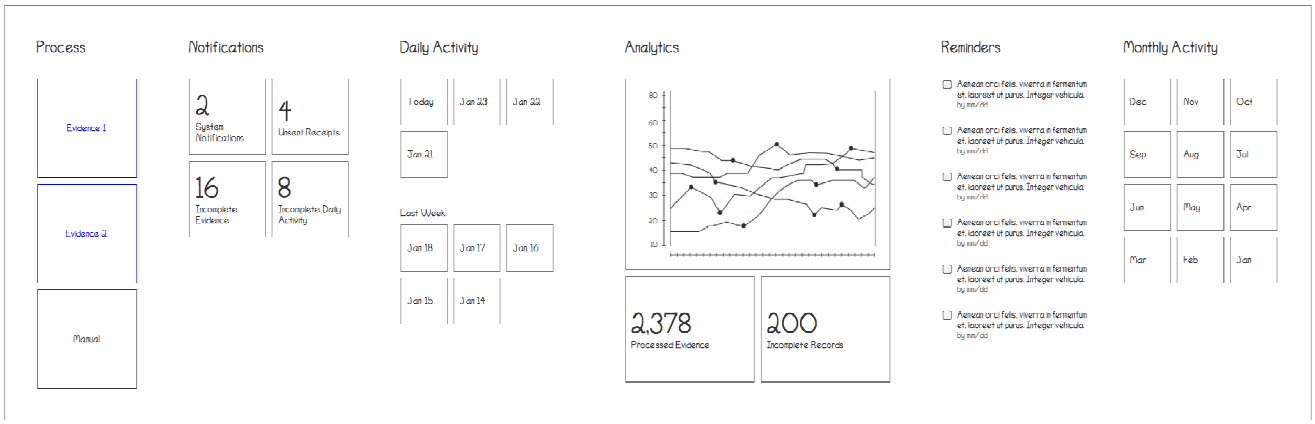

FIGURE 4. A SAMPLE WIREFRAME TRANSLATING THE NEWLY IDENTIFIED WORKFLOWS INTO A USER INTERFACE OF A DESKTOP APPLICATION.

answers into the PDF that we would collect electronically. For evaluation, we used established usability metrics:

- **Task completion** was recorded as successful when the participant indicated the scenario's goal had been obtained [5], whether successfully or unsuccessfully.
- **Critical errors** are deviations from completion of the scenario goals, whether stemming from unresolved errors during the process of completing the task or errors that produce an incorrect outcome [5]. Independent completion of the scenario was our goal since the session was held remotely with facilitators participating in the teleconference.
- **Non-critical errors** are errors that can be recovered from and do not prevent the participant from completing the task [5]. Our observation of non-critical errors was limited due to the remote nature of the session.
- **Subjective evaluations** were collected in the concept section of the survey. The questionnaire utilized a five-point Likert rating scale to obtain self-reported data [5] on usefulness, ease of use, ease of learning, and overall satisfaction.

All answers were analyzed and the findings were recorded in a concept validation report that guided further refinement of the new evidence-processing methodology and development of the application.

IMPLEMENTATION

During software implementation into the client's network infrastructure, we again faced limited access and policy restrictions that prevented us from deploying remote testing technology or observing participants in person to gather feedback on the application's performance. Resorting to a pen-and-paper method, we created data capture forms (see Fig. 5) that enabled participants to record session feedback, but that did not overwhelm them by adding a lot of work on top of their daily responsibilities.

With each new deployment, we met with the participants and gathered additional feedback in the form of a retrospective think-aloud protocol, where participants verbalized what they were feeling and thinking after they completed a task, revealing not only aspects of an interface that delighted, confused or frustrated them, but also their reasoning, intentions and strategy behind a task [4 pp.180]. This information helped improve the overall usability of the user interface.

Once we gathered this quantitative and qualitative data about the application use and reviewed sample records created during initial deployments, we were able to define how much the application sped up the process and brought value to the client in four key areas: the amount of time required, manual work, process automation, and record accuracy. Fig. 6 clearly shows the decrease in time commitment and manual work, and the increase in process automation and record accuracy.

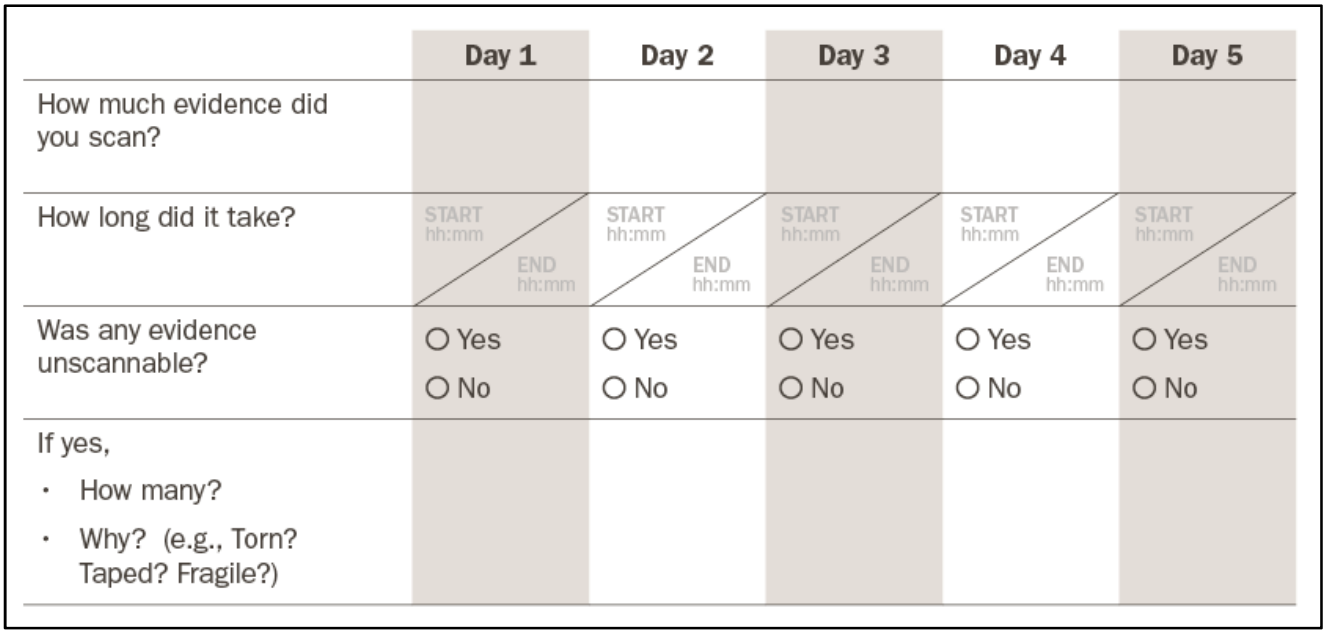

FIGURE 5. EXAMPLE OF THE PAPER-BASED DATA CAPTURE FORM WE USED TO GATHER FEEDBACK ON THE APPLICATION PERFORMANCE.

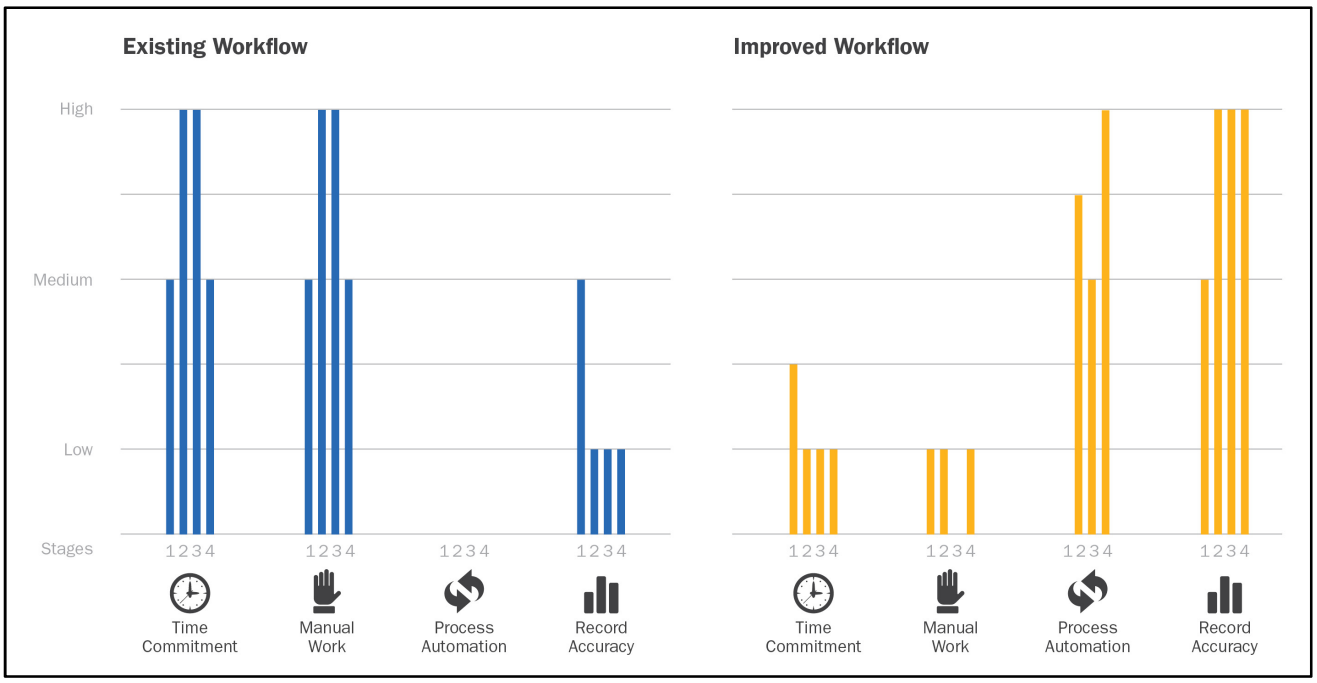

FIGURE 6. ABSTRACTED COMPARISON OF EXISTING AND IMPROVED WORKFLOW USING THE DATA GATHERED DURING IMPLMENTATION.

CONCLUSION

The design research methods discussed above were crucial in gathering the necessary evidence and presenting a synthesized, meaningful picture of the problems at hand to the client. They enabled us to directly involve the client in the design process and helped the client make informed decisions regarding the future system and its seamless integration into the technical infrastructure. Furthermore, by directly engaging the future users, we were able to clearly define the necessary workflows the system would go through to improve and standardize the current state of practice and position it for successful transition and adoption of the system.

ACKNOWLEDGEMENTS

This material is based upon work funded and supported by USSS under Contract No. FA8721-05-C-0003 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center sponsored by the United States Department of Defense.

This material has been approved for public release and unlimited distribution.

DM-0001414

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