Design-with-Efficiency:

Toward a Streamlined Process for Electronics-Industry Design Engineers

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TFI SUPPLY CHAIN

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Since 1987, clients have turned to Technology Forecasters Inc. for strategic advice and market insights to optimize global manufacturing relationships and achieve profitable environmental strategies. With clients in the Americas, EMEA, and Asia, TFI delivers a unique combination of industry and environmental expertise through management consulting, customized research, keynotes, and workshops. TFI Supply Chain researches and consults on best practices for the electronics industry from supply and manufacturing through logistics.

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About the Study's Sponsor

Launched in June 2009, element14 is the first information portal, collaborative community, and electronics store specifically built for electronics design engineers. The community recently unveiled its element14 knode, a unique automated platform that enables engineers to quickly research, design, develop, and prototype in a single, intelligent environment. element14 is an innovative offering from Premier Farnell plc, a leader in multi-channel electronics distribution trading throughout Europe (Farnell), the Americas (Newark), and Asia Pacific (element14). Premier Farnell is dedicated to serving the needs of the global design engineering community and commissioned TFI to complete this independent study as a way of eliciting ideas directly from design engineers on the topic of driving greater efficiencies throughout the design process.

For more information on the element14 knode, please visit http://www.element14.com/knode.

WHY TFI STUDIED DESIGN ENGINEERS' PROCESSES

The electronics industry's key focus in the past decade has been on the supply chain: globalizing it, reducing its costs and risk, optimizing it, and auditing it for ethical conduct. As important as these issues are, this intense focus on suppliers has overshadowed perhaps the most important determinant of a successful supply chain: the design phase. Like captains of huge ships, electronics design engineers make hourly and daily decisions that steer their companies' supply chains toward new technologies, divergent regions, lead-time factors, environmental sustainability, and competitiveness. It made sense to us — the consultants at Technology Forecasters Inc. (TFI) — that by providing design engineers with quick-to-find, reliable information about their myriad choices in design approach and components, these "captains" can traverse any kind of seas with speed and predictable success.

Design Engineers' Processes: from Pain to Efficiency

Today, electronics design engineers are burdened with lengthy and disparate processes comprising dozens of technical documents, design tools, "expert" advice, product searches, evaluations, regulatory requirements, and promises of availability. There has to be a more efficient way. The purpose of this white paper, therefore, is to chronicle the "pain" that design engineers experience in finding and aggregating all the necessary information, data, and tools, and then to point to ways engineers would prefer to navigate design choices. Our primary methodology was surveying design engineers working around the world, sharing their authentic processes, sources, complaints, and ideas.

> "For new product, I actually pick out the system architecture first and then spend a lot of time looking at new solutions and technologies. I spend so much time collecting this information, and a lot has to be analyzed."
>
> — **Developer of Printer and Copier Products, China**

What We Discovered (in Preview)

Design engineers face a variety of challenges related to the acquisition and assimilation of a wide array of technical information, tools, and data; these challenges are amplified as they embark on new projects or incorporate new technologies into their designs. Primary "pain points" for electronics design engineers include:

1. Initial design stages (before prototype assembly and testing) typically require the most time and effort to gather all the necessary information.
2. There's never enough time to properly utilize every relevant source.
3. Incomplete information is common across relevant sources.
4. Managing customer and vendor relations throughout the design process can be complicated, consuming even more time and resources.

Specific items essential to the design process that can be difficult to find are:

1. Reference designs
2. Application notes
3. Simulation models
4. Component pricing and availability
5. Component failure rates
6. Component lifecycle data

> "My largest challenges in finding and aggregating critical information I need to support the design process, from start to finish, are the timeliness of information updates, trying to understand what suppliers are planning to develop in the future, dealing with internal and external specification changes, and determining how to effectively evaluate different options available for the same design. For example, there may be five suppliers that can meet my need for a particular function; is there a resource available other than making the engineer set up a spreadsheet listing pros and cons of the five options? Is there a tool that can assist us with this?"
>
> — **Principal Engineer Component Technology, North America**

Engineers reported that they could benefit from (1) more streamlined design resources that obviate the need to seek and check so many sources, and (2) collaboration with people working on other stages of the product lifecycle, as well as other engineers in an online community.

STUDY METHODOLOGY

Any electronic product you use today may have been designed in part by an original design manufacturer in China, a design shop in Colorado, and a name-brand company in Hungary. We realized at the onset of this study that to elicit meaningful experiences from a representative pool of electronics design engineers, we would need to survey and interview engineers not only in diverse industrial sectors (computers, telecom, automotive electronics, defense/aerospace, medical instrumentation) and age groups, but also in all global geographies as well as at in-sourced (name-brand company) and outsourced (contract manufacturer and design shop) venues.

We at TFI took the research steps outlined in Table 1.

TABLE 1
Research Methodology

1. **Designed two questionnaires for electronics design engineers and managers.** One was for telephone interviews, and the other for a web-based survey. A number of TFI's clients and colleagues (especially Mike Kirschner) contributed to the question design.
2. **Invited electronics design engineers worldwide to take the web survey.** Sources of engineers were from TFI's contact data base, Electronic Products magazine (Hearst), CircuitNet, EBN On-line (UBM), Elektronik Tidningen, Connect Press, EMSNow.com, and other publications targeted at electronics design engineers around the globe.
3. **Qualified the engineer respondents and achieved a large response.** We achieved 50% more qualified, completed web-survey responses than we had targeted. To determine qualification, the following two questions had to be answered in the affirmative: (1) Is your engineering specialization one of the following: (a) electrical hardware design (PCB, analog, digital, etc.), (b) embedded software design, or (c) FPGA design? And (2) Do you spend at least 30% percent of your time at work performing or supervising electronics design or R&D projects?
4. **Conducted telephone interviews for detailed exploration.** To capture and respect the "voice" of the electronics designer, Anne Feith and the co-authors interviewed by telephone several dozen electronics design engineers and managers in a balance of global geographic regions to discuss in depth the processes used, challenges encountered, and desires for the future.
5. **Analyzed the results through an objective lens.** TFI analysts handled the data analysis. We provided all research participants with a complimentary copy of this white paper along with two other TFI white papers on related topics.

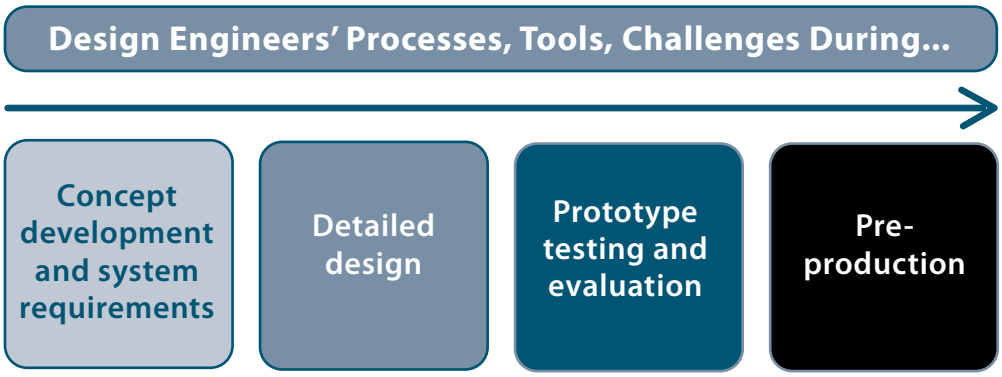
The international scope of our research meant reaching out to name-brand electronics companies (OEMs) from Vestel in Turkey, to Tellabs in the USA, to Cellcom in India; contract manufacturers from Kaifa (Shenzhen) Technology in China, to PartnerTech in Sweden, to Mack Technologies in the USA; and engineering services companies from Proteus in Vietnam, to Electronic Productions in the USA, to the Centre for Development of Advanced Computing in India.

Examples of the topics discussed with engineers follow:

- Amount of time they spent searching for information in each of four design stages (described in Figure A), and level of difficulty in finding the materials information and design advice needed.
- The most difficult types of information to find, and the greatest challenges faced in looking for it.
- Percentage of time searching online for necessary data.
- Level of interest in consolidated information sources, and what silos of info could be joined.
- Value of online blogs, forums, and engineering communities.
- Profile: Company end products, respondent's specialization, age.

FIGURE A

Four Stages of Electronics Design Covered in the Study



Following are the regional breakouts of the telephone interviews and web surveys:

- Telephone interviews (38 total): 32% in the Americas; 32% in Europe, the Middle East, and Africa (EMEA); and 36% in Asia
- Web surveys (we deemed 290 to be "qualified" out of 440 survey "starts"): 82% in the Americas; 5% in EMEA; 5% in Asia; and 8% not specifying

The industrial sectors of the qualified engineers surveyed are presented in Figure B, with ages in Figure C:

FIGURE B

Respondents' Industrial Sectors

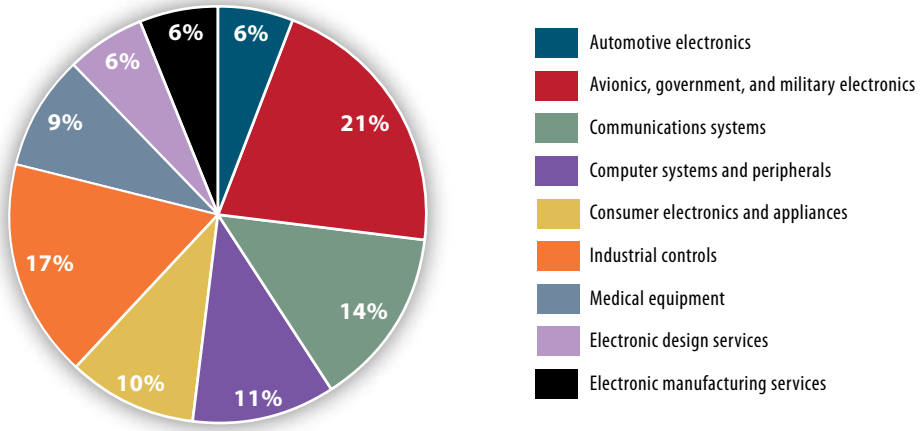
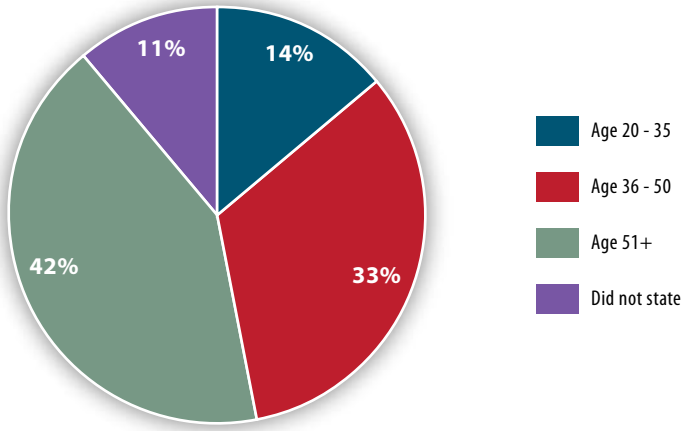


FIGURE C

Ages of Engineers Taking the Web Survey



For any questions about the study's methodology, we invite you to write to Info@TechForecasters.com.

TOP CHALLENGES OF ELECTRONICS DESIGN

We began by investigating the core problem and underlying factors. We know that the electronics design process includes aspects that are cumbersome, time-consuming, and inefficient. By probing carefully into these aspects, we sought to uncover the main "pain points" experienced by today's electronics engineers regarding the critical information and tools they need to do their work.

General Challenges in the Design Process

To understand the design challenges more precisely, we divided the design process into four stages as noted previously: Concept development, Detailed design, Prototype testing and evaluation, and Pre-production. The engineers we interviewed agreed that these are relevant and accurately named stages. For each stage, we asked about the time spent finding and aggregating key information, data, and tools (which could include application notes, reference designs, component specifications, development tools, operating systems and stacks, etc.).

Table 2 shows the results from the web survey. The first two design stages demand more time for information seeking than the latter two and are more challenging in this regard. In a broad sense, this finding is not surprising. The earlier stages involve locating particular components that conform to specs, comparing options, and coordinating the performance of interacting parts — all of which require a great deal of information. The phone interviews showed an even greater disparity between the first two and last two stages, again with the initial stages requiring more time. It is interesting to note that a slight variation correlates with age, with younger engineers experiencing more difficulty on average than older ones in all four stages: 3.2 compared to 2.8 on Detailed Design. Table 2 shows the overall average of 3.0.

TABLE 2
Time Spent and Degree of Difficulty by Stage in the Design Process

Design stage	Average percentage of time spent finding and aggregating information, data, and tools	Average degree of difficulty in finding and aggregating the information, data, and tools (1 = extremely easy, 5 = extremely difficult)
Concept Development	41%	3.0
Detailed Design	45%	3.0
Prototype Testing and Evaluation	36%	2.7
Pre-Production	25%	2.5

Next we probed on the magnitude of particular challenges that may occur during the design process. Again we used a scale from 1 (not a problem) to 5 (extremely challenging) on the web survey. As indicated in Figure D, "Just not enough time" and "Incomplete information" stand out as the most challenging. For these two issues, there was age-based variance for "Just not enough time" as older engineers reported comparatively more difficulty with time constraints than younger ones (an average of 3.3 for age 20 to 35, 3.8 for age 36 to 50, and 3.6 for age 51+).

One can imagine a design engineer diligently seeking to fulfill customer needs but encountering difficulty getting all the required information, while simultaneously feeling there's never enough time to resolve the issues that surface along the way. The phone interviews support this general picture and also add more nuance, as follows:

- ***Information overload:*** "It is not so much difficult as it is time consuming." (Medium-sized European contract manufacturer) "There is just too much information out there…. It is tough to find something simple and just move on…. It is weeding it out that takes the time. Once you find what you want, you usually get accurate information." (Small North American design house)
- ***New designs and technologies are more challenging:*** "It depends on the project: If it is something standard, it will not take as long. But if it is new, it will take longer to look at the new companies and new technologies." (Small European design house) "For new projects it is difficult because you may need a lot of things to find a solution. For repeat designs, much less is needed." (Large Asian contract manufacturer)
- ***Some suppliers are easier than others:*** "The difficulty really depends on the set of suppliers we have chosen…. Some are very difficult to get information from." (Large North American telecom company)

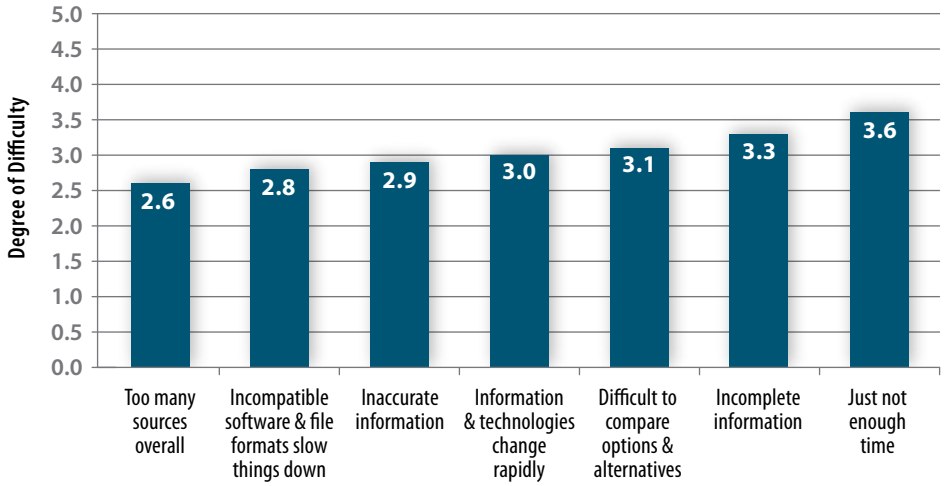
> **"[We find it difficult to find and aggregate] resources, because we have some projects running in parallel and also need to support current production products with end-of-life or quality issues."**
>
> — **Electronics Design Engineer, Israel**

Another challenge cited frequently in the phone interviews was customer communication; this is especially true for designers who work in the role of contractors or consultants, but may also apply to engineers at large companies who must satisfy a number of internal clients. They noted that customers may not have a clear understanding of all requirements at the initial stages of the design process, and they will sometimes change their specs well after work has already begun.

Patience, flexibility, and clear communication are required to ease the process. Said one manager in a large Asian contract manufacturing firm, "The biggest challenge is the requirement from the customer — how well we understand the need, and how our design can cover the changes that will always occur." And a large North American contract manufacturer noted, "For automotive, everything must be written down even to the last comma. To translate the wishes of the customer is the most time consuming and complex process, because the customer may not understand all the technology."

FIGURE D

Challenges in the Design Process



Specific Types of Information That Are Challenging

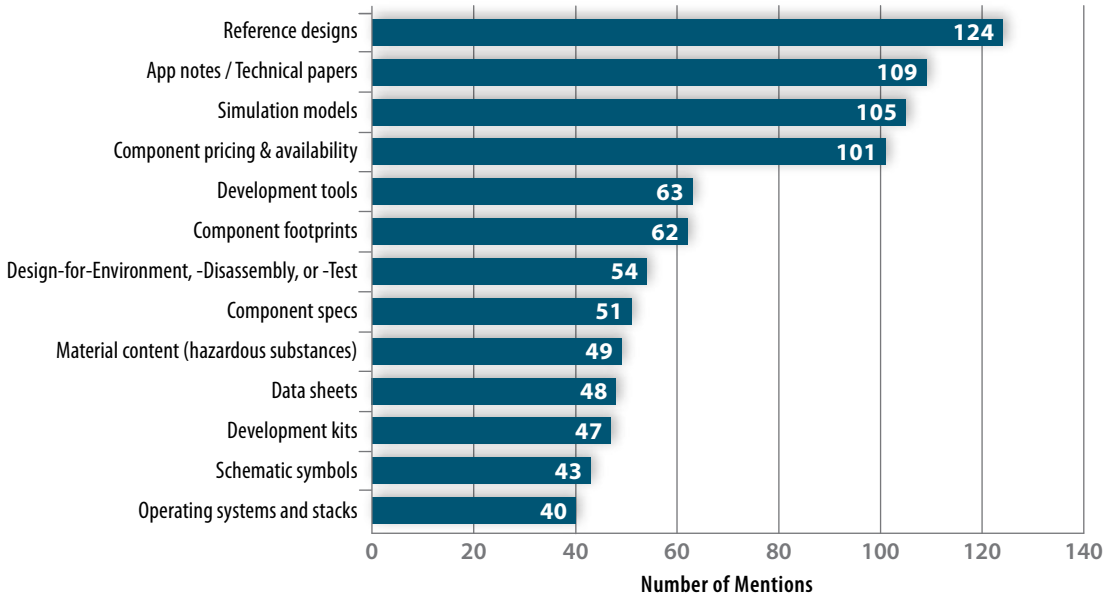
We probed more deeply into the specific types of information, data, and tools that are the most challenging to find and aggregate, asking respondents to cite their top three choices in this regard. Figure E depicts the resources that stand out as being the most difficult from the web survey, in this order: Reference designs, application notes, simulation models, and component pricing and availability.

It seems that top-level information about component characteristics and performance is generally available online — but more detailed, sophisticated, and (in the case of pricing) time-specific information and tools can be difficult to locate. Difficulty levels may also vary based on the nature of relationships with key vendors, as illustrated in this quote: "We divide data sheets and components into how confidential they are…usually they are available on the web, but for specific chips they are proprietary. So getting data can be a real problem if we don't have a connection/channel with the vendor. But once we have a relationship and an NDA (non-disclosure agreement), it gets easier." (Medium-sized North American telecom vendor)

As an engineer consults with vendor representatives on technical issues, he or she must also be wary of the possibility of bias or prejudicial advice: "I talk with the support engineers or field engineers at the manufacturers. Maybe 50% of the time I get the feeling that they just want to sell me the part, but I always take that into consideration. If I have a long relationship with the engineers, they will provide a solution rather than try to sell me something." (Large North American optoelectronics manufacturer)

FIGURE E

Most Challenging Types of Information, Data, and Tools to Find and Aggregate



Actual survey question: *"Of the following types of information, tools and data, check the THREE that are typically the MOST difficult to find and aggregate in the course of your design."*

In the phone interviews, respondents in a variety of fields said that finding end-of-life (EOL) information about components is particularly difficult. Engineers used the term "end of life" in reference to two different concepts, each very important to the ultimate success of a product design: First, EOL could literally refer to the life of a component — when and how it fails to perform over time. Alternatively, EOL could reference the timing or likelihood that a component will no longer be manufactured or widely available in the market. Said a manager at a large North American telecom vendor: "One of the things we struggle with is trying to find out the longevity of a device. There might be devices that were put on market five years ago that meet our needs, and also newer ones that meet our needs. The challenge is that the older technology will not be around as long as the newer technology."

Equipped with a deeper understanding of the overall issues and underlying, causative factors, we proceeded to more carefully explore the portion of the design process that is conducted online.

"I normally have three methods for looking for the information I need: I spend 50% of my time on the Internet, and the rest looking at existing supplier channels and the historical record through previous experience."

— Design Engineer China

THE PERILS AND PROMISES OF ONLINE DATA AND TOOLS

Naturally, the Internet has become a critical tool in the engineering design process. We sought to discover how online resources are used, which ones are proving most helpful, challenges commonly encountered, and a sense for potential improvements.

Engagement with Online Tools

According to respondents, of all the time spent searching for information and tools, about half of it is done online — approaching 60% for the youngest age category. The other half tends to occur in three areas: (1) talking with vendors on the phone; nearly all engineers do this, even after they've found information online, (2) using internal company databases and tools, especially for large firms, and (3) meeting with vendors to learn about new technologies or explore details of their design (again, more common for large firms). A final common activity for many engineers involves customer communications (face-to-face, on the phone, or by email). Many respondents mentioned that the online portion is increasing, and they expect that trend to continue.

When searching online, it's no surprise that engineers consult a multitude of different sources. For the earlier stages of the design process, designers may use up to a few dozen sites, while the final two stages usually require fewer than 10. The range of online sources consulted is highly variable based upon the requirements of the design as well as the habits of an individual engineer. Again, it is clear that the earlier stages are more demanding in terms of the disparate types of information required.

Engineers rely most heavily on three primary sources of information: Search engines, manufacturers' websites, and distributors' websites. Most engineers have developed a loose checklist of sites that they visit regularly for their projects. Also a fourth source is the emerging option of professional social media tools — this new option is explored more thoroughly in the section below. A comparison of all four primary sources can be found at the end of that section.

Specific Challenges with Online Information

In the previous section, we mapped out the overall "pain points" in the design process and identified certain types of information and tools that are particularly challenging to find, aggregate, and integrate. Not surprisingly, the heavy use of online tools to sift through huge volumes of data has produced some unique challenges of its own. The telephone interviews provided especially rich information on this related coincidental trend. Three primary challenges were mentioned many times in a variety of ways:

1. Comparing components and design options
2. Handling regulatory considerations in an environment of rapid change and different standards by country
3. Gaining access to information that requires a fee

Accurate and Complete Comparisons

By far, the most commonly cited challenge was comparing different design options — either comparing the components themselves, or comparing different layouts or technical approaches. The underlying reasons for the difficulty are rooted in the following issues:

- Incomplete and disparate information. Naturally, manufacturers and distributors only list the products they sell. In the words of a North American designer, "Usually a site gives vendor specific data; I have to do all the comparison legwork myself. It would be nice if a site gave me all the info about a certain type of chip (say, processor chips), even if they are from different vendors."
- There are few, if any, standards for reporting performance and test data. "There's no standard across manufacturers for how a data sheet is put together. One may put in 'typical' values, and another may put in 'worst case' values. Some 'sugar coat' the data sheets with 'best case' values where they have optimized all the specs individually, but that combination cannot appear in reality!…What we need most is a way to compare components and know for sure that it is apples-to-apples." (Small North American design house)

The aforementioned issues force engineers to tediously search a multitude of sites and do the legwork to make the comparisons themselves. Some actually enjoy certain aspects of this process, as they can apply their own judgment while learning about new technology and bolstering their own knowledge base. Others find very little to enjoy, feeling squeezed by a cumbersome and inefficient process — hoping for more common standards and websites that provide rigorous comparisons in a more intuitive and accessible fashion. In all cases, engineers

were sensitive to the fact that the information provider may have an interest in steering them toward a particular product. This is one reason that "generic" search engines (like Google) are so widely employed; they are viewed as more objective and comprehensive.

To Pay or Not to Pay?

The structure of the Internet allows information providers to charge fees for access to certain data or tools. Some engineers reported a strong reluctance to use *fee-based websites*, sometimes choosing to forgo these sites due to limited funds and budgets already stretched to the max. "Some of these specialized search engines force you to be a member and pay a fee — I usually do not use those." (Large Asian contract manufacturer)

Necessity to Capture Data on Product Content and Other Regulatory Matters

The challenge of finding *regulatory information* is becoming more and more critical. Regulations concerning hazardous materials, energy use, and other environmental considerations are increasing in number and differ greatly by country. More and more, design engineers are expected to have some competence in sorting through the complicated set of applicable regulations: "For us a big challenge is the regulations and policies in different countries — every country has its own. We spend a lot of time here." (Large Asian contract manufacturer) Several mentioned running into challenges with certain electronics being regulated by ITAR (International Traffic in Arms Regulations).

Although design-for-environment (DfE) information was not listed as a major challenge in Figure E, it is closely related to this regulatory information and will become progressively more important in the future.

The Very Real Perils of Online Data Searching

The general lack of standardized and easily accessible information, data, and tools for electronics design in the virtual world can lead to very serious problems in the physical world! Consider these two examples:

- "One time, we got a call from a previous customer, and it turned out that one component had caught fire! The housing of a metallic component had melted. It took us a week to find accurate information about why. We finally found an obscure source that said under special conditions it could combust. But during the design phase we had missed this — it was too obscure. A very difficult situation with the customer." (Large North American optoelectronics vendor)
- "This week my boss paid $50K for a [network component], and it turns out it doesn't conform to the specifications, and now they won't even let us return it to them for our money back!…a very expensive mistake." (Small North American telecom company)

Clearly there is room for improvement in the system.

Is There Optimism about Improvement?

The emerging picture is that the Internet provides a vast quantity of information and tools that are now essential for the electronics design process, but engineers are challenged to integrate all this data effectively within

the short time frame they have to complete projects. We asked specific questions about whether engineers would like to have resources that (1) cover multiple stages of the design cycle, and/or (2) provide consolidated information across vendors, distributors, publications and other players in the supply chain.

The results revealed a complex landscape of views. Overall, many engineers thought resources with these two qualities were a good idea in principle: About 80% said that each of them would be "extremely helpful" or "very helpful." Speaking in favor of consolidating information, an engineer at a small North American communications company said, "I have to go to many different places looking for data sheets, international standards, and other things, and then I have to pull it together. It is multiple sites, different for each process, and must be tailored to what I am doing."

However, many engineers (sometimes the same one who had praised the idea in concept) also expressed doubt about whether it is feasible or practical for anyone to create such a resource, and even if it did exist, whether they would fully trust it.

- One said, "I think suppliers would not be willing to provide upfront information to this [consolidated] site because their competitors might gain access to the information. I see this with information on new releases, where the access is password-protected and you need permission to download. I even see this for devices that have been released for several years." (Large North American telecom company)
- Another pointed out, "The biggest difficulties would be what to include and what to leave out; how to make the navigation easy; and how to make it big enough to be useful for many people, yet not so big that nobody can find their way around it." (Large North American company)
- A third said, "The biggest problem I see would be keeping current. The bigger the database, the more effort it takes to keep it up to date. It is frustrating to go to a site and then find out that the situation or information has changed. This is the blessing/curse of the Internet. I've been burned a couple times with bogus information." (Small North American avionics company)

One approach to streamlining the search and aggregation of all this information is to break down the silos within engineers' own organizations. A new form of web resource is emerging that is based on creating a community of engineers so that they can more easily share resources and expertise.

New Resources: Online Technical Forums, Blogs, and Engineering Communities

Engineers know engineering best. When a design engineer needs to know the detailed performance of a component, he or she will trust another engineer before a salesperson or technical representative from a vendor or distributor. (As one engineer said bluntly: "If they give me a salesperson without an engineering degree, then I don't trust them 90% of the time regarding their technical answers.") Hence, it is natural that engineers

are beginning to find avenues to share information directly during the design process, sometimes crossing company and country lines. Online, this may take various forms:

- Discussion forums, where visitors can read and post comments on a variety of topics
- Blogs, where one expert writes an opinion piece, and others comment
- Full-fledged engineering communities, where additional and more sophisticated connection services are provided (such as access to experts)

All of these are part of an emerging class of resources based in social media, which take advantage of collective knowledge and people's natural tendency to share ideas and help each other. Sometimes online forums and professional community sites allow anonymous users, while others require registration and a real identity. Some are free, and some have various levels of paid membership.

Our research touched on how electronics design engineers are using these new online resources, but this study does not purport to be a comprehensive review of this dynamic landscape. Nonetheless, as we conducted our interviews, the picture emerged of a system with two major and rather separate components. First, there are international forums and online communities that use English. Nearly all professional engineers have some proficiency in English (although a few in our interviews did note that they have some challenges acquiring information because English is their second language). A second main branch of the online engineering world is exclusively in Chinese. These sites are sometimes government-sponsored and sometimes created by groups of individuals.

Overall, 73% of web survey respondents said that they visit these forums, blogs, and engineering communities. Table 3 shows that there is some spread in age — more young engineers than older ones use these sites. But the larger age discrepancy is in frequency of visits and how useful these media are perceived to be. About twice as many young engineers reported using such sites at least weekly. They also found the sites significantly more useful across all stages of the design process.

TABLE 3

Age Differences in the Use of Online Forums, Blogs, and Engineering Communities

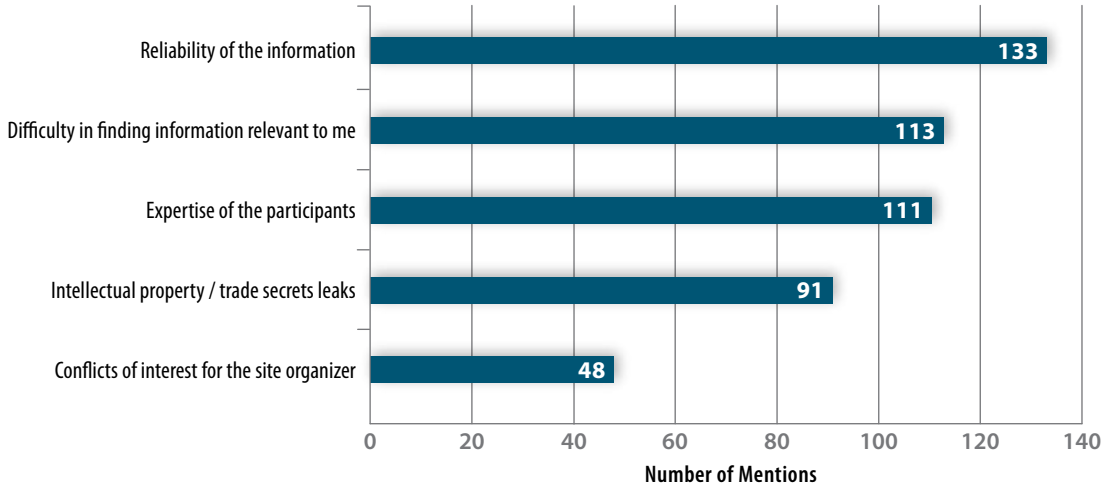
Age range	Percent who visit forums, blogs, and engineering communities	Percent of visitors who do so at least weekly	Percent who rate the sites "Extremely useful" or "Somewhat useful"			
			Concept Development	Detailed Design	Prototype Testing and Evaluation	Pre-Production
20-35	78%	66%	77%	74%	71%	45%
36-50	76%	37%	62%	55%	47%	22%
51+	71%	33%	57%	60%	29%	15%

In the phone interviews, we probed further on specific actions engineers might normally perform on these sites. The engineers we interviewed were much more likely to passively read the information and conversations than post their own questions or answers. Here are some typical quotes: "Mostly I search other people's questions and do not ask my own. I want to know if a lot of people have reported a certain problem and see all the suggested solutions." (Medium-sized North American telecom vendor) "In that forum it's difficult to share information — I can only provide top-level information, not details, because I don't know the whole story behind someone's question." (Large North American optoelectronics vendor)

On both the web and phone surveys, we asked about any concerns people have about online forums and communities. Figure F shows results from the web survey. The largest concern is *reliability of the information*, followed by *difficulty in finding relevant information*.

FIGURE F

Concerns with Online Forums, Blogs, and Engineering Communities



Actual survey question: *Do you have any concerns or challenges with using online forums or technical communities? (Check all that apply)."*

The above concerns and some additional ones articulated in the phone interviews include the following:

- "When you do a search, there are so many options and mixed opinions. You do not know if you are reading something from the manufacturer, or if it is a personal opinion. You need to ensure that the writer is not biased in any way." (Small North American consulting design house)
- "The anonymity of [some of] these sites is problematic. Unless you can affirm who's answering, it is hard to trust the person." (Small North American avionics vendor)
- "I have no real concerns, but one should always double-check information." (European design consultant)

It is interesting to note that while intellectual property (IP) concerns are problematic for some, they may not qualify as a key barrier for others. Many respondents mentioned that they do not feel concerned about IP because they understand their company's policy and simply do not post anything that could violate it; they assume others do the same.

Looking broadly at all the detailed conversations with engineers as well as the hundreds of web survey responses, we can now step back and summarize the pros and cons of these professional social media sites as a category, relative to the three typical online sources discussed in the previous section (Table 4).

TABLE 4
Qualities of Key Online Information Sources

Source	Advantages	Disadvantages
Search engines	• Comprehensive and neutral: Will give all the information	• Difficult and time-consuming to separate the wheat from the chaff
Manufacturer/vendor websites	• Accurate and detailed information on specific components	• Cannot compare to other manufacturers' products • No standard for how data is presented • Intention to "sell something" to the engineer
Distributor websites	• Combines the higher-quality information characteristic of manufacturers' sites with a more comprehensive view of the options	• Still has the taint of "wanting to sell" • May not have the detailed technical knowledge of a manufacturer
Forums, blogs, communities	• Can learn what major issues other engineers are encountering • No pressure to buy • Can interact directly with other engineers	• Uncertain quality of the information (must verify and double-check) • Difficult to find relevant information • Anonymity of members

Technical forums, blogs, and engineering communities offer the potential to provide a useful new dimension to how engineers find, aggregate, and utilize critical information for their designs. They provide a direct link between engineers, including those working at different stages of the design cycle and across different industries. They appeal to the younger generation of engineers who are highly proficient with social media in general. Although respondents in our study cited a few important reservations around quickly finding the key data they trust implicitly, it is possible that such sites will take their place alongside more traditional online options in the near future.

In the next section we consider possibilities for easing design engineers' information-gathering process through innovative online options. And we also highlight new trends and information that design engineers will need to consider more carefully, such as design-for-environment.

TOWARD A MORE STREAMLINED DESIGN PROCESS

Now that the engineers have described in detail the key challenges they face almost daily, we turn toward some of the solutions they requested for making their role — the start of the entire supply chain — more efficient. They reported, overall, that they would like (1) a more streamlined design resource that obviates the need to seek and check so many sources, which takes so much time, and (2) collaboration with people working on complementary stages of the product lifecycle, as well as other engineers in an online community.

Joining Silos of Information and Other Suggestions for Solutions

We asked about which silos of information might be most usefully joined, what other tools/services could be useful for finding and aggregating information, and other related ideas. The engineers told us their decisions enable a more efficient and successful supply chain when they can easily glean insights from chip designers, experts in environmental and safety regulations, manufacturing facilities, software designers, customers, and other stakeholders in addition to the more traditional or readily accessible sources. Of course, the engineers themselves have a good sense of what is needed, as evidenced by the following quotes from our interviews:

- "It is very helpful to get vendors online with board designers because of the value of the interaction. I think having more chip vendors, board PCB designers, and technology people all together online would be very helpful. Another useful set would be VHDL and FPGA experts." (Small European design house)
- "I would like to merge detailed design with pricing considerations — the first is early in the design cycle, while pricing happens in later stages. The more these can be integrated, the more confident I am that I'm creating a valid approach from early in the design cycle. I can tell ahead of time if the part is readily available, isn't about to go end-of-life, has good pricing, etc. Distribution sites are the best for integrating all of this. But still, I use multiple computer notebooks to compare information side-by-side in real time." (Small North American avionics vendor)

- "We need regulatory and EMC/safety/green standards information." (Medium-sized European network security vendor)
- "I would like design data sheets, application notes, and new solutions based on the experience of other companies who used them. I would like to see real production data so I can learn the experience from failure data. I also would like to see the different approaches if we want to design a new solution — what is available and which one is best? I need to look at balanced data and all the elements." (Large Asian printer/copier company)
- "Customer feedback is one of the most important pieces of information in order to improve the development of the products." (Italian telecom company)

Solutions specifically requested by the engineers include the following:

- ***Product lifecycle information:*** "I would like an overall component lifecycle status, telling us which components are mature and their availability over the next few years. For us, many of our products are long life, so it is a key concern to know when these products were placed on the market and are nearing end of life. We have put processes in place internally to gather this information, and there are a few fee-based services that help us with this, but this is a cost. If some of this was available more publically, it would help the engineers." (Large North American telecom company)
- ***Search engine:*** "I think a good search engine would do the job; most of the time I use Google. I usually have a lot of links, including numerous junk links to get to the correct data. But it takes a lot of time to filter and remove the junk. Secondly, many times I have some requests that I cannot express with regular Google language; usually I know what I want, but I cannot get a straight answer for simple questions because the search returns millions of sites and there is data overload." (Small European design house)
- ***The whole "shebang"!:*** "I would like to see these categories: First I would like the commodities categorized. There are thousands of components amongst the competitors, and we would like to see some logic around this. Secondly I would like to see a comparison amongst the major components, the top components, and how they compare against each other. The third is the pricing, making sure it is all together. The fourth is the commonality of all those components. The fifth is historical usage or the current customers' historical shipment — some sense of the consumption on those components. The last one would be the roadmap for those sustaining components, including new technologies and other plans." (Large Asian contract manufacturer)

Perhaps some of the most fragmented and rapidly changing data fall into the global environmental and trade regulations arena. Ideal would be to have design-for-environment

information easily accessible at engineers' fingertips. Perhaps professional social media sites could play a role. Ultimately, designers need to be in a position to more quickly and reliably access the full material content for the components they design into end products being shipped all over the globe.

Looking to the Future: Consolidation of Reliable Resources

It may not be soon that a single resource aggregates all component information, design tools, regulatory data, parts availability, pricing, and other relevant data that the engineers report they need to ensure a successful start to the supply chain. In fact, from studying engineers' processes around the world across a variety of company types and sizes, we predict that engineers would not want to start and end their search with only one resource; some engineers in our study explicitly stated that they would not trust a single "go-to" entity. But we do anticipate that by consolidating necessary and even "nice to have" information in a few objective, well-run search communities, engineers' processes will be more efficient and decisions more exacting. The end result will be better products going to market, faster cycle times, fewer design changes, and fewer surprises about cost, availability, and regulatory compliance.

As we head toward a future characterized by more accessible, consolidated, and reliable resources, we firmly believe that eliciting the voices of design engineers around the world — as we did for this study — will continue to be an essential prerequisite for success. We thank the hundreds of engineers who contributed to this study, and we wish them well on their ongoing mission to enhance the efficiency of their design processes.

About the Co-Authors

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Pamela J. Gordon, Certified Management Consultant, has been tracking electronics design through manufacturing strategies since 1984, when working for McGraw-Hill / DRI subsidiary Gnostic Concepts. Then in 1987 she formed Technology Forecasters Inc. Today TFI has 18 consultants and analysts around the world creating strategies for clients in efficient design through manufacturing and also logistics and product use as well as profitable, responsible post-use treatment. As president of TFI and lead consultant for TFI Supply Chain and TFI Environment, Ms. Gordon was the executive manager of this research project.

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Kimberly Allen has been a TFI consultant since 2007, supporting electronics-industry clients with efficient, sustainable solutions for numerous aspects of both products and corporate operations. Before joining TFI she had seven years' experience in market analysis with iSuppli Corp., mainly in the areas of emerging electronic display technology and cost modeling. With a PhD in Physics and MBA in Sustainable Business, she approaches best-practice benchmarking with strong quantitative analysis while keeping business and environmental benefit at top of mind. Dr. Allen, along with TFI Senior Analyst Anne Feith, conducted the primary research and analysis.

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