

BOOK REVIEW

The Ultimate Guide to Business Process Management

By Tim Corder

Standards development organizations (SDOs) are unique entities. While you can learn about various business topics by reading books, completing online training, or attending seminars, it feels as if a decoder ring or Rosetta Stone is needed to connect the material you study to the day-to-day activities of an SDO.

Those of us who work at UL Standards & Engagement, a nonprofit, mission-driven organization dedicated to “Putting Safety Science In Action,” don’t generally consider ourselves to be selling a “product.” We may not feel as if we have customers; instead, we have “stakeholders.” This can make it even more difficult to connect our SDO activities to books, seminars, and training intended for traditional companies that sell widgets to customers for a profit.

And yet, UL Standards & Engagement does sell something—standards, the proceeds from which are reinvested into our mission. Our stakeholders pay a considerable amount of money to purchase our standards. I suspect that a stakeholder spending nearly \$1,600 to purchase a three-year subscription to UL 508A, Standard for Industrial Control Panels, *feels* that she is a customer, and I also suspect that she has needs she hopes will be filled by making that purchase. She may still have unmet needs even after subscribing to UL 508A. It might be possible that if UL Standards & Engagement could fulfill those unmet needs,

we might more fully advance our mission to make the world a safer, more secure, and more sustainable place.

Toward that end, UL Standards & Engagement has established a new team whose focus is solely on process excellence. I have the honor to lead this freshly born team.

In my new role, I’m attempting to quickly learn the basics of business process management (BPM). As a first step, I’ve read *The Ultimate Guide to Business Process Management* by Theodore Panagacos. The book’s subtitle says the book contains “Everything you need to know about how to apply (BPM) to your organization.” As my new team is still in its infancy, I am not able to confirm that the book succeeds in fulfilling this promise. However, I have found it to be of great value in considering what my team is to accomplish, how it will accomplish it, and why a structured approach to process analysis and process change is important.

The book begins by defining BPM as “the science of building, identifying, and managing processes so they can be improved for maximum efficiency. BPM deals with identifying all the processes associated with your organization; analyzing them for efficiency and effectiveness; measuring the results over a period of time; and optimizing these processes.”

These days, SDOs are challenged to fulfill their stakeholders’ needs faster and faster as

technology changes more and more quickly. In the case of UL Standards & Engagement, the pace of new safety concerns that accompany technological advancement seems to be increasing at an exponential rate. We must find ways to balance consensus-based standards development (historically a protracted process) against the increased velocity at which our stakeholders and mission need new or revised standards.

"Typically," Panagacos writes, "BPM focuses on three core benefits—efficiency, effectiveness, and agility." UL Standards & Engagement's Process Excellence Team is focused on implementing BPM to realize these benefits, as we believe efficiency, effectiveness, and agility are critical in overcoming modern challenges associated with standards development.

The author shares five critical success factors in implementing BPM, the first of which is developing a BPM strategy. "Having a BPM strategy that completely aligns with the organization's business goals is the first and most critical success factor," Panagacos writes. This alignment with the organization's goals helps ensure the second critical success factor, stakeholder commitment and empowerment, is met. Regarding this success factor, Panagacos states, "Executive sponsorship is an absolute 'must have' prior to implementing a BPM strategy. It is crucial that higher management gives their required attention, support, funding, commitment and time in order for the organization to reap the true benefits from BPM."

Changing long-standing, complicated, and mission-critical processes will be challenging for UL Standards & Engagement. Our team members will be asked to embrace process changes. These process changes likely will come with new systems to support the evolved processes. Our team members will be asked to learn these new systems. Further, we expect our processes and systems to continually evolve, so our team members will be challenged to embrace continuous change.

To support our team members, change management will be critical. A major component of change management is the visible support of change efforts by executive leadership. To secure that support, the Process Excellence Team will have to ensure our processes are aligned with our organization's objectives and that our leadership sees this alignment and supports our efforts to implement process changes.

The introductory part of *The Ultimate Guide to Business Process Management* covers 10 pitfalls to avoid when implementing BPM. One of these pitfalls is "Implementing IT-led BPM." As Panagacos writes, "Any BPM initiative that is led by IT is doomed to failure."

It can be tempting to focus on IT-based solutions, as technology is capable of fantastic things. (Perhaps what you are currently reading was written by ChatGPT?) While technology is vital in supporting the execution of processes, process analysis must come before the implementation of new technology. Attempts should not be made to improve inefficient and/or ineffective processes solely through new tech. Instead, process analysis should lead to the definition of business requirements of technology that can be pursued by IT.

After introducing BPM, Panagacos turns to where BPM should be positioned in an organization. The author shares that BPM is a change function and, as such, "must be placed in an area of the organization where its processes can be managed and governed from the top down." Panagacos lists two other functions that should be above the BPM function, those being business strategy and business architecture. He defines business strategy as "... the team that's responsible for helping the CEO determine where the organization is headed long term," while business architecture is the "team to work out what the organization should look like so that it can achieve (Business Strategy's) plans."

As next in the hierarchy, the BPM team considers the strategy and architecture to "... develop process models that illustrate end-to-

end processes that start with the customer and end with the customer.” The example given focuses on the sale of toys to customers.

Does UL Standards & Engagement have a business strategy group that helps to determine where the organization is headed in the long term? Sure, we do. Do we have a business architecture team to work out what the organization should look like? Yes, we do. Our Process Excellence Team (BPM Team) will take this higher-level strategy and architecture information and connect them, through our processes, to our stakeholders.

The Ultimate Guide to Business Process Management also provides practical guidance regarding roles that are typically part of a BPM team, those being the process analyst (Level 1), process architect (Level 2), senior process practitioner (Level 3), and process steward. I’ve appreciated that it includes well-defined descriptions of these roles, which have been helpful as I start to build out our Process Excellence Team.

The book shares more practical information regarding process modeling, analysis, and measurement—core services that a BPM team provides. These services are part of the continuous eight-step BPM Activity Cycle: (1) Process Definition; (2) Design; (3) Simulation; (4) Deployment; (5) Execution; (6) Monitoring; (7) Analysis; and (8) Optimization. More guidance is provided regarding the development, storage, and sharing of process artifacts, guides, and procedures.

The book goes on to share information regarding career development, competencies, and certifications that BPM team members

might pursue. Mentioned are Business Process Management Notation (BPMN 1.2 and 2.0), The Open Group Architecture Framework (TOGAF), Lean, and Six Sigma. It also provides details about systems that a BPM team might find useful. All this information I’ve found valuable in considering what knowledge our Process Excellence Team members should either already have in joining our team or learn after joining us. Much of this I will benefit from learning as well.

While I suspect that Theodore Panagacos did not have SDOs in mind while writing this book, I have found it easy to connect what it shares to UL Standards & Engagement, my new role, and our new Process Excellence Team. It was concise, 177 pages, and provided me with sufficient detail to establish a vision of the Process Excellence Team. I’ve found it necessary to do research outside of the book, such as learning more about BPMN 1.2 and 2.0 and TOGAF. However, prior to reading the book, I was not aware that these were things I needed to consider.

UL Standards & Engagement isn’t a typical company, but we will benefit from having a team focused on connecting our processes to our organization’s objectives and meeting our stakeholders’ needs. We will be more successful by doing so in an intentional and structured way, continuously analyzing, and improving our process’s efficiency, effectiveness, and agility. *The Ultimate Guide to Business Process Management* has been helpful in establishing the fundamentals of what our team will do and how we will do it.



Tim Corder has been a part of UL Standards & Engagement for 25 years. He has held several roles with the organization including Standards Engineer, Standards Operations Manager, Technical Committee Chair, and Standards Program Manager. He currently serves as Process Excellence Manager in UL Standards & Engagements newly formed Process Excellence Team.

Standardization Can Leverage Skills Outside STEM Fields

By Monica R. Diaz

As a professional outside of the STEM fields, I had never heard of standardization prior to my first professional contact with it. My interests and passions led me to study energy-related topics, particularly electricity and regulation, that eventually became my specialty areas. Some of my decisions led me to my first professional experience in the energy sector, at the Ministry of Energy in Mexico, where I undoubtedly obtained great experiences and knowledge. However, I still had not come across standardization.

Standardization is a critical component in many industries, including the energy sector. It establishes guidelines and minimum criteria for quality, safety, and design, and is essential for facilitating foreign trade and boosting the competitiveness of companies, countries, and entire regions. While many STEM professionals are familiar with standardization, those outside of these fields may not be aware of its importance and impact.

I continued my career path and began to work at the Mexican Energy Regulatory Commission, where I developed professionally and specialized in electricity regulation. Eventually, I found myself in an area that I never imagined: the unit dedicated to developing Mexican standards in the field of electricity. After just a few weeks in this fascinating world, I began to ask myself what I could

bring to the table and how I could contribute to standardization when I was surrounded by electrical engineers, and I had studied international relations.

It was there that I encountered fundamental concepts for any professional who wants to participate in the field of standardization: negotiation, consensus building and technical barriers to trade. The latter resonated particularly with me, because standards seek to establish guidelines and minimum criteria for quality, safety, and design (among many other things) that must not only achieve technical objectives but also help facilitate foreign trade and boost the competitiveness of companies as well as countries and entire regions. It was this concept that helped me realize I could contribute my skills to standardization by generating information and documents to point out the benefits and opportunities that Mexico gains by participating in the development of international standards.

Consensus building (along with negotiating) is one of the biggest challenges that emerging professionals—and experienced ones as well—working with standards or in standards development can face. My opportunity to gain experience in consensus building and apply these skills came in 2020, when I participated in the Mexican Program

for Young Professionals of the Mexican Electrotechnical Committee. This was a highly enriching experience, where I had the opportunity to talk with leaders and experts in standardization in areas as diverse as energy efficiency and telecommunications.

Thanks to this program, I was able to represent Mexico as a young professional in an IEC General Assembly in Dubai where, along with brilliant and young colleagues, I experienced firsthand the challenges of building consensus and negotiating to develop a standard.

There I verified that my analysis, communication, and leadership skills can make an important contribution in a highly specialized and technical world that, in the end, has the objective of benefiting the entire population.

This has been, until now, my professional path in standardization. My experiences and lessons lead me to say with certainty that I would encourage professionals outside the STEM fields to learn and develop their skills in the world of national and international standardization.



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LEADING THROUGH CHANGE

Team Development

By Alexis Shoemaker

The science of team science “encompasses an amalgam of conceptual and methodologic strategies aimed at understanding and enhancing the outcomes of large-scale collaborative programs” (Stokols et al. 2008). This field provides a compelling framework for team development and illustrates “the impact of interpersonal processes and leadership styles on scientific collaboration” (Stokols et al. 2008).

This article will discuss fostering team competencies and individual skills, team building, conflict management, and culture construction and maintenance.

TEAM COMPETENCIES AND INDIVIDUAL SKILLS

Interdisciplinarity is an inherent aspect of teams. Each member of the team comes to the table with valuable skills and dynamic perspectives. The literature on this subject demonstrates “a coordinated effort to synthesize concepts and methods from respective disciplines in such a way that a common but much more complex goal is met” (Fiore 2008).

Shared knowledge structures are an effective way to accommodate and develop skills and perspectives on teams. These structures allow a team to overcome the distributed expertise that defines transdisciplinary endeavors. To “effectively combine these disparate knowledge-bases,” teams can

“establish shared mental models, which are organized knowledge structures” (Benishek et al. 2014). In many ways, the process of knowledge sharing is a facet of culture curation. Culture inherently comprises many subcultures, and a leader’s ability to bridge those gaps is critical.

Transactive memory systems are another useful tool for building team competency. These systems are “a cooperative division of labor for learning, remembering, and communicating relevant team knowledge” (Benishek et al. 2014). This technique distributes expertise and allows members “to specialize deeply in their preferred disciplines” (Benishek et al. 2014).

Mentorship links to the broader idea of team competencies, shared knowledge structures, and transactive memory systems, as they all involve formal and informal methods of knowledge transfer. An effective “mentor recognizes the strengths of each team member, identifies areas in which [colleagues] have the greatest potential to grow, and can help coach people to attain their aspirations” (Bennett, Gadlin, and Marchand 2010). Mentorship functions on a few levels: it “recognizes the strengths of team members,” empowers teammates to be leaders and teachers, fosters interpersonal ties, facilitates communication and collaboration, and distributes the responsibility of training (Bennett, Gadlin, and Marchand 2010).

In practice, shared knowledge structures, transactive memory systems, and mentorship empower “team members with unique expertise to combine their disparate knowledge into a novel product or outcome that extends beyond any one discipline” (Benishek et al. 2014). These tools are “associated with improved team effectiveness, team learning, and member satisfaction” (Benishek et al. 2014).

TEAM BUILDING

Team building for effective collaboration can be challenging, as there are several abstract and interconnected group and individual dynamics to account for. Directly impacting the task of outcome creation are affective, behavioral, intellectual, and interpersonal forces.

“Affective processes refer to those beliefs and feelings team members possess that impact other team processes and outcomes. Behavioral processes are those physical activities in which team members engage to build team objectives. Intellectual processes describe the team’s cognitions and efforts to generate novel ideas and integrate conceptual frameworks. Interpersonal processes refer to the dynamics that take place between team members” (Benishek et al. 2014).

Conflicts can be either relationship-based or process-based. They can be “both a challenge and a resource” (Bennett, Gadlin, and Marchand 2010). Handled well, conflict can result in new knowledge and expanded thinking (Bennett, Gadlin, and Marchand 2010). Handled poorly, conflict can “impede effective team functioning [and] stifle advancement” (Bennett, Gadlin, and Marchand 2010). Glauner and Jones (2018) suggest keeping three words in mind in the face of conflict: recognition, respect, and reconciliation. “The effective management of conflict allows creativity and collaboration to flourish in translational teams, thereby improving their abil-

ity to generate new outcomes” (Benishek et al. 2014).

By understanding the nuances of individual and group dynamics and the affective, behavioral, intellectual, and interpersonal processes at play, leaders are empowered to effectively build their team and bring in impactful new talent, both of which ultimately contribute to a well-rounded team.

CONCLUSION

Translational teams pose a unique challenge for leaders, especially in the face of change. These teams often have delicate shared knowledge structures and transactive memory systems that depend on consistency. Team building, too, demands a leader’s understanding of the nuanced culture of a team so they may fortify what works and abate what doesn’t. By identifying and reinforcing these modes of knowledge transfer, leaders can ensure their team weathers change.

The next column in this series will discuss strategic planning and building capacity as it pertains to change leadership.

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Assessment of Perceived and Measured Tribometer Readings in Evaluating Wet Barefoot Slip Resistance: A Gait-Based Approach

By Russell J. Kendzior

Can assessing slip risk (as quantified during human subject walking trials) lead to a better understanding of the perceived versus measured levels of slip resistance of surfaces intended to be walked upon with bare wet feet (e.g., floors, bathtubs, and swimming pool decks)?

According to the U.S. Consumer Protection Safety Commission (CPSC), emergency departments in U.S. hospitals and health care facilities treated approximately 790,000 bathtub- and shower- related injuries among children less than 18 years of age from 1990 through 2007, with an average of 43,600 cases per year or equating to ~5.9 such injuries per 10,000 U.S. children per year. The largest number of injuries involved children 2 years of age and children less than 4 years of age accounted for 54.3% of injuries. The most common diagnosis was lacerations (59.5%); The most common mechanism of injury was a slip, trip, or fall, accounting for 81.0% of cases or 4.6 injuries per 10 000 US children per year. The most frequently injured body parts was were the face (48.0%) and the head/neck (15.0%). Most injuries (71.3%) occurred in a bathtub. Of the cases with a known place of injury, 97.1% occurred at home. An estimated 2.8% of patients were admitted, transferred to another hospital, or held for observation.”

Studies have revealed that when a person’s gait is extended, the required level of slip resistance increases. Therefore, the required level of wet barefoot slip resistance is greater for flooring materials used in places where a person’s stride is longer than usual, whereas less slip resistance is needed for bathtubs, showers, and spas, where the user’s gait and stride are greatly reduced. The quantification of measured versus perceived slip resistance has not been studied. Many bathing-related slip and fall events occur when an individual is pivoting or shuffling their feet while standing in a bathing unit or when stepping into or onto a wet surface.

In 2016, ASTM International withdrew the F-462 Standard Consumer Safety Specification for Slip-Resistant Bathing Facilities without issuing a replacement. Currently there are no standardized test methods for measuring the slip resistance (traction) of surfaces intended to be walked upon under wet barefoot conditions.

There is a wide range of skin variables on human feet, including skin thickness on different areas of the foot (toes, heels, soles, etc.) Human sensory perception also varies among individuals and is age related. Musculoskeletal factors, calluses, and foot neuropathy all can affect how people perceive

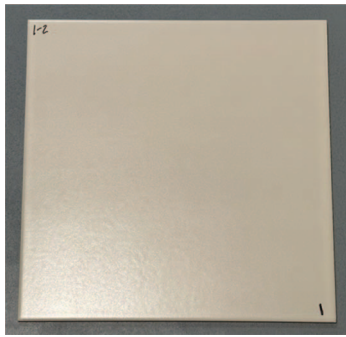


Figure 1. CINCA NOVA Architettura 3332M Glazed Ceramic Tile, Matt finish.

the slip resistance of a surface when walking barefooted.

Given the need for additional research in this area, the National Floor Safety Institute (NFSI) conducted a two-part study to assess the viability of using perceived slipperiness (as quantified during human subject walking trials) to define acceptable traction ranges for pedestrians walking on wet barefoot surfaces. First, human subjects objectively ranked the slipperiness of five different surfaces that were contaminated using a 0.1% sodium lauryl sulfate (SLS) solution. Second, three tribometers approved by the National Floor Safety Institute (NFSI) were used to measure the wet Dynamic Coefficient of Friction (DCOF) of each surface. The human subject and tribometer measurements were then compared using the two criteria described above.

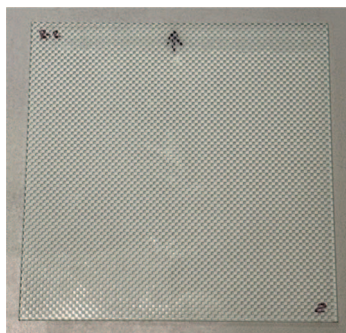


Figure 2. NFSI High-Traction Validation Reference Surface.



Figure 3. NFSI Low-Traction Validation Reference Surface.

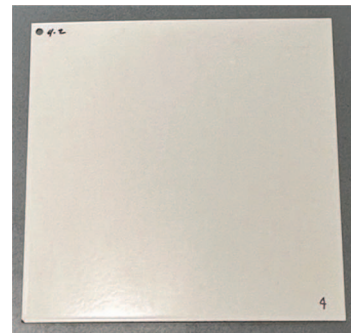


Figure 4. Porcelain Enamel Finished Steel Coating, (Bootz Corporation).

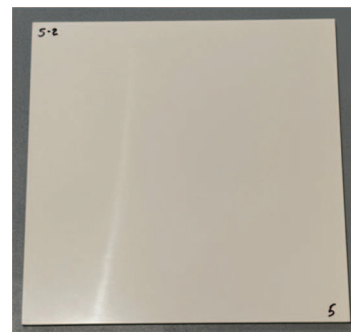


Figure 5. Casalgrande Padana Granito Unicolore Bianco Assolute Polished Porcelain Tile.

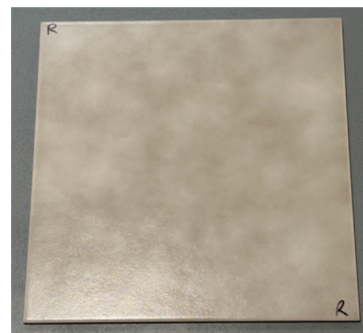


Figure 6. Control Reference Surface- NFSI Calibration Reference Surface Tile.



Figure 7. Metal handrail fixture.

METHODS FOR HUMAN SUBJECT TESTING

The study parameters were as follows:

Test subjects: Seventy volunteer subjects (35 males, 35 females) between the ages of 17 and 65 (mean age 41.5 years) were recruited for the study. All subjects were healthy and capable of independent ambulation and had no physical disabilities.

Walkway surfaces and conditions: Five smooth to moderately smooth surface materials and one reference surface were affixed to a plastic tray mounted on the floor of an enclosed metal handrail fixture. Each surface was wetted using a 0.1% dilution of sodium lauryl sulfate.

The five surfaces used in the study were the following:

1. CINCA NOVA Architettura 3332M Glazed Ceramic Tile, matt finish;
2. NFSI High-Traction Validation Reference Surface;
3. NFSI Low-Traction Validation Reference Surface;
4. Porcelain Enamel Finished Steel Coating (Bootz Corporation); and
5. Casalgrande Padana Granito Unicolore Bianco Assolute Polished Porcelain Tile.

Table 1. Surface average wet DCOF test results are listed in Table 1

Surface	GS-1	TRACSCAN2.0	ASM925
1.	0.34	0.30	0.308
2.	0.60	0.62	0.726
3.	0.17	0.19	0.194
4.	0.75	0.74	0.828
5.	0.32	0.26	0.309
Reference	0.20	0.25	0.215

Procedures: All testing was performed at the NFSI Research Center in Southlake, Texas. The temperature and humidity in the laboratory were controlled. Participants entered a metal handrail fixture (see the accompanying photo) containing each of the five surfaces and one reference surface. Subjects were barefooted and were instructed to step onto each test surface and take a series of short steps along its surface. The study participants then ranked the perceived level of slipperiness of each surface on a scale of one to ten. Each subject was monitored by an NFSI technician.

Perception of slipperiness: After completing each trial, study participants ranked the perceived level of slip resistance of each of the five surfaces. Rankings were based on a scale from 1 to 10, where a 1 represented a surface with a higher level of slip resistance than that of the control and a 10 represented a lower level of slip resistance than that of the control.

Tribometers: Three NFSI-approved tribometers were used to measure the DCOF of the six surfaces: the TRACSCAN 2.0, the ASM-925, and the GS-1.3 Each tribometer was operated by an experienced, factory-trained technician, and testing was performed according to the tribometer manufacturer's instructions. The DCOF of each surface was tested using the NFSI B101.3 Test Method for Measuring the Wet DCOF of Hard Surface Walkways.

Testing procedures: Tribometer testing was conducted on all six surfaces using NFSI B101.3. The same solution and wetting proto-

Table 2. *Human Subject Ranking Results-* The results of the human subject walking trials are presented in Table 2

Volunteer	Gender	Age Range	Surface 1	Surface 2	Surface 3	Surface 4	Surface 5
1	Female	Under 17	3	1	4	3	7
2	Female	Under 17	5	1	4	3	8
3	Female	Under 17	4	1	2	1	8
4	Female	Under 17	5	4	1	2	10
5	Female	Under 17	4	2	3	1	10
AVG.			4.2	1.8	2.8	2	8.6
6	Male	Under 17	2	2	5	4	10
7	Male	Under 17	5	1	2	1	5
8	Male	Under 17	5	3	3	1	8
9	Male	Under 17	4	2	3	2	8
10	Male	Under 17	5	3	3	3	9
AVG.			4.2	2.2	3.2	2.2	8
11	Female	18 - 25	3	5	9	1	8
12	Female	18 - 25	4	1	3	1	8
13	Female	18 - 25	3	2	2	1	7
14	Female	18 - 25	2	2	4	1	7
15	Female	18 - 25	4	2	3	1	7
AVG.			3.2	2.4	4.2	1	7.4
16	Male	18 - 25	3	2	2	3	7
17	Male	18 - 25	4	2	3	6	9
18	Male	18 - 25	4	3	3	2	8
19	Male	18 - 25	6	2	2	3	8
20	Male	18 - 25	8	2	3	1	8
AVG.			5	2.2	2.6	3	8
21	Female	26 - 35	4	1	3	1	8
22	Female	26 - 35	4	2	3	2	7
23	Female	26 - 35	6	4	3	2	10
24	Female	26 - 35	5	3	1	2	9
25	Female	26 - 35	5	3	1	1	9
AVG.			4.8	2.6	2.2	1.6	8.6
26	Male	26 - 35	8	1	9	1	10
27	Male	26 - 35	8	2	2	1	9
28	Male	26 - 35	2	2	5	4	10
29	Male	26 - 35	6	4	2	1	9
30	Male	26 - 35	6	3	3	1	9
AVG.			6	2.4	4.2	1.6	9.4
31	Female	36 - 45	10	2	7	2	10
32	Female	36 - 45	4	2	3	2	7
33	Female	36 - 45	4	2	3	2	7
34	Female	36 - 45	6	2	4	2	8
35	Female	36 - 45	6	1	3	1	9
AVG.			6	1.8	4	1.8	8.2
TOT. AVG.			5.3	2	3.8	2.2	8.7
RANK			4	1	3	2	5
36	Male	36 - 45	5	2	3	3	5
37	Male	36 - 45	5	2	3	3	5
38	Male	36 - 45	4	1	2	1	8
39	Male	36 - 45	6	3	5	2	9
40	Male	36 - 45	7	3	4	3	10
AVG.			6.4	2.2	3.4	2.4	7.4
41	Female	46 - 55	8	1	6	1	10
42	Female	46 - 55	7	1	3	2	10
43	Female	46 - 55	8	1	4	1	10
44	Female	46 - 55	5	2	2	1	10
45	Female	46 - 55	8	2	3	1	10
AVG.			7.2	1.4	3.6	1.2	10
46	Male	46 - 55	4	2	3	2	7
47	Male	46 - 55	5	3	2	2	10
48	Male	46 - 55	4	1	2	1	8
49	Male	46 - 55	7	2	2	1	9
50	Male	46 - 55	5	2	3	2	7
AVG.			5	2	2.4	1.6	8.2
51	Female	56 - 65	5	3	4	2	8
52	Female	56 - 65	4	2	7	1	9
53	Female	56 - 65	4	8	6	7	10
54	Female	56 - 65	4	2	6	1	8
55	Female	56 - 65	8	5	3	6	10
AVG.			5	4	5.2	3.4	9
56	Male	56 - 65	8	2	6	1	10
57	Male	56 - 65	3	1	6	2	10
58	Male	56 - 65	5	2	3	2	9
59	Male	56 - 65	8	3	5	6	10
60	Male	56 - 65	7	3	5	4	9
AVG.			6.2	2.2	5	3	9.6
61	Female	Over 65	8	1	5	2	10
62	Female	Over 65	8	1	5	4	10
63	Female	Over 65	3	1	4	3	7
64	Female	Over 65	5	1	4	3	8
65	Female	Over 65	8	3	5	4	9
AVG.			6.4	1.4	4.2	3.2	8.8
66	Male	Over 65	7	3	5	5	10
67	Male	Over 65	4	1	5	2	10
68	Male	Over 65	4	1	9	2	10
69	Male	Over 65	4	2	3	1	10
70	Male	Over 65	2	2	5	4	10
AVG.			4.2	1.8	5.4	2.8	10

col used in the human subject tests was used for the tribometer tests. When testing wet surfaces, each tribometer's test foot was dried thoroughly before testing the next wet surface. For each surface condition, the DCOF was measured in each of four perpendicular directions, (at 0, 90, 180, and 270 degrees) as specified by NFSI B101.3. Surface average wet DCOF test results are listed in Table 1.

DATA ANALYSIS

The slipperiness rankings determined from the walking trials were considered the refer-

ence against which the tribometer measurements were compared. The results of the tribometer measurements were then compared with the gait-based subject ranking of each surface's perceived slipperiness. Results are listed in Tables 2 and 3.

Wet DCOF levels of 0.34 or less were perceived by all the test subjects as being slippery to very slippery. Wet DCOF levels of 0.60 or greater were perceived by all the test subjects as not being slippery. Subjects identified surfaces with a wet DCOF level of 0.34 to 0.26 to be more slippery than the reference surface, whose wet DCOF ranged between 0.20-

ASSESSMENT OF PERCEIVED AND MEASURED TRIBOMETER READINGS IN EVALUATING WET BAREFOOT SLIP RESISTANCE

Table 3. The results of the tribometer measurements were then compared with the gait-based subject ranking of each surfaces perceived slipperiness and are listed in Table 3

Surfaces	GS-1	TRACSCAN 2.0	ASM 925	Subject Rank
1.	3	3	4	4
2.	2	2	2	1
3.	5	5	5	3
4.	1	1	1	2
5.	4	4	3	5

Surface Rankings (1=Least Slippery, 5=Most Slippery)

0.25. This may have been attributable to texture variances in each of the smooth surfaces.

The surface that exhibited a high level of traction from all human subjects was that of a conventional enamel-coated bathtub. Thus, enameled bathing surfaces are capable of providing a sufficient level of slip resistance; therefore, manufacturers of enamel bathtubs are capable of producing high-traction bathing surfaces.

This study shows that tribometers, which are routinely used to assess the safety of pedestrian walkways, offer great benefits when used for testing the DCOF of bathtubs, showers, spas, and other surfaces intended to be used under wet barefoot conditions. Our experimental protocol demonstrated that a subjective gait-based system of analysis can be used to establish accurate levels of required slip resistance for surfaces intended to be walked upon under wet barefoot conditions. The gait-based analysis correlated wet DCOF values with human subjects' perceptions of surface slipperiness. Much of the referenced research identifies perception as a key factor in identifying potential slip risk, which we confirmed and correlated.

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RESEARCH-ARTICLE

Standards and the Law

By Cary Coglianese

The world of standards is typically viewed as separate from the world of laws. Standards, after all, are often described using adjectives such as “voluntary” and “consensus.” Standards-development organizations are not in the business of producing mandatory or legally binding standards; that business is the responsibility of legislatures, agencies, and courts. But even though the world of standards and the world of laws seem separate, they are actually more closely intertwined than many professionals working with laws or standards realize.

Standards intersect with and affect the law in numerous ways. They serve as benchmarks to determine liability and as frames of reference to facilitate domestic and international transactions handled by lawyers. They prompt legal negotiations over the licensing of patented technologies needed to conform to standards—and when these negotiations break down, they spill over into court battles.

Standards can also sometimes be incorporated into laws and regulations, thereby becoming binding. They can even govern the processing of evidence in the judicial system, affecting highly consequential decisions about criminal liability.

This article explains how standards come into play in six major domains of law: product liability, patent law, contracts, administrative law, international trade, and criminal law. Although examples are provided from

the United States, similar intersections between standards and the law apply in other jurisdictions. Seeing the connections between standards and the law can help legal professionals better appreciate the important role that standards play in the economy; equally, it can help standards professionals better understand how their work affects the legal system.

PRODUCT LIABILITY

When standards specify how products should be designed, especially for reasons of safety and health, they can determine the applicable standard of care in product liability cases. Because the overarching standard of care for proving negligence is generally an open-ended one of “reasonable care,” lawyers and judges will look to relevant voluntary standards for guidance.

This is why courts in some states have specifically ruled that violating a voluntary standard for product safety is presumptively a sign of negligence (*M & R Investment Co. v. Anzalotti*). State legislatures have also passed statutes establishing a connection between standards and products liability. The state of Washington’s Products Liability Act, for example, allows juries in product liability cases to consider conformity to standards in determining whether a manufacturer has been negligent (Washington Revised Code 1981).

The connection between liability and standards also works to protect manufacturers. Legislatures in some states having approved laws providing that conformity with a relevant standard protects manufacturers from liability. Conformity, in other words, can create a rebuttable presumption that a product poses no unreasonable risk of harm.

Even in cases when product liability is determined under a liability test where negligence of the seller need not be proven, such as strict liability, standards are also sometimes accepted by courts as pivotal evidence. The strict liability standard adopted in many U.S. states basically holds sellers liable for harms caused by any products that are deemed to be “unreasonably dangerous” (ALI 1965). In these states, standards may be used by some courts in assessing whether a product meets the test of reasonable safety.

In California, for example, a strict liability test asks if a “product’s design creates preventable danger that is excessive in relation to the advantages of the design.” The state Supreme Court has held that conformity (or non-conformity) with standards can be relevant in assessing the risks and benefits of a product design (*Kim v. Toyota Motor Corp.*). Of course, some other states have differed—the Pennsylvania Supreme Court, for example, has held that conformity with an American Society of Mechanical Engineers standard was not relevant in a strict liability case (*Lewis v. Coffing Hoist Div., Duff-Norton Co.*).

PATENT LAW

Patents grant property rights and protections to the inventors of new products, machines, and processes, preventing others from using patented innovations without getting a license to do so from the patent owner. Many professionals in the standards world may already be familiar with issues surrounding standard-essential patents. When a standard necessitates the use of a technology protected by a patent, that patent is seen as a “standard-essential” one.

Based on contractual obligations, and consistent with the American National Standards Institute’s patent policy, the owner of a standard-essential patent must license its intellectual property to others on terms that are fair, reasonable, and non-discriminatory, or FRAND (Dahl 2020). (Sometimes professionals just use the term RAND, as “fair” and “reasonable” can be considered synonyms.)

The legal obligation to license standard-essential patents on FRAND terms helps prevent holdouts by patent owners seeking to extract rents from licensees. But as the words that comprise the FRAND acronym suggest, what is fair, reasonable, and non-discriminatory may not always be self-evident and uncontroversial. Although standard-setting organizations establish the expectations that standard-essential patents will be licensed on FRAND terms, they do not determine what counts as FRAND in any specific case. Patent owners and licensees must negotiate over license terms.

Sometimes these negotiations have broken down. In these instances, courts have provided some specificity to what FRAND entails. The federal court in *Georgia-Pacific Corp. v. United States Plywood Corp.* (1970) articulated a widely applied 15-factor test for assessing damages in patent infringement cases. In 2013, another federal court elaborated on the *Georgia-Pacific* test and modified it to apply to a standard-essential patent dispute more generally (*Microsoft v. Motorola*). Among other things, the court determined that when damages call for calculating the value of the patent, a court should not include the enhanced value that accrues due to the existence of a standard that necessitates the use of the patent. Instead, a court should just look to the value of the patent by itself.

These are not easy judgments to make. Over the last decade, a variety of other disputes over FRAND terms have resulted in litigation (Renaud, Wodarski, and Weinger 2020). The impact of standards on patent law practice—and on the outcomes of courts’ decisions in

patent disputes—will likely persist for many years to come.

CONTRACTS

As noted, the basis for a patent owner's FRAND obligation ultimately derives from contract law, as courts have found the membership agreements between patent owners and standard-setting organizations imply such an obligation. But standards can figure into legal contracts in many other ways.

Standards are often at the center of business transactions. Just as standards can be used to define the standard of care in product liability cases, they can be used as reference points for parties in defining contractual obligations. Contract language for goods or services often specifies that these goods and services must conform to specific industry standards, making contractually binding what otherwise might be "voluntary."

When disputes arise over compliance with the standards referenced in contracts, they can end up in court, where judges are asked to award remedies if the goods or services do not meet the standards specified in the contract. For example, when a crude oil contract called for independent third-party testing of the oil based on standards issues by ASTM International and the American Petroleum Institute, a court held that "the failure of such independent third party to follow the standards or procedures prescribed in the contract will invalidate any certification or determination so made" (*Cities Service Company v. Derby & Company*). In this way, standards often become the benchmarks for performance in contract disputes handled by lawyers.

ADMINISTRATIVE LAW

Administrative law refers to the body of procedures and doctrines that govern how commissions, boards, and agencies go about their work, such as making binding law through the rulemaking process. Each year, federal administrative agencies in the United

States issue thousands of rules, which are subsequently published in the *Federal Register*.

Some of these rules or regulations simply borrow from voluntary standards, thereby making them mandatory. In fact, the National Technology Transfer and Advancement Act (NTTAA) specifically encourages federal agencies that develop regulations to "use technical standards that are developed or adopted by voluntary consensus standards bodies" whenever practical (NTTAA 1996).

Often the incorporation of standards into regulations occurs "by reference." This means that the agency's rule does not actually spell out what the incorporated standard says, but simply refers to that standard using the name of the standard-setting organization and the name or number of the standard. According to a database maintained by the National Institute of Standards and Technology (NIST), federal regulations currently contain more than 26,000 provisions that incorporate standards by reference (NIST 2023).

Ordinarily, laws and regulations must be published in free, publicly accessible sources, such as the *Federal Register*. But because standards are created by private standard-setting organizations, many incorporated standards are copyrighted and cannot be reprinted in the *Federal Register* (Bremer 2015). This has led critics of the practice of incorporation by reference to charge that the process lacks transparency.

The Administrative Procedure Act only allows agencies to incorporate standards by reference into their regulations when the standards can still be made "reasonably available" to the public (APA 1967). Usually this requirement is met by a regulatory agency making the standard available for physical inspection at the agency's headquarters. As a practical matter, however, a regulated entity or member of the public seeking to read the content of an incorporated standard and understand what the law requires may need to purchase the standard from the standard-setting organization.

INTERNATIONAL TRADE

Standards can be important vehicles for facilitating international trade, such as by ensuring the interoperability of technologies and providing a common floor of safety and other product performance characteristics. But standards can serve as barriers to trade as well, especially if different standards apply in different countries. As a result, standards can pose large economic stakes for private businesses around the world.

The World Trade Organization's Agreement on Technical Barriers to Trade (WTO TBT) has sought to limit attempts by national governments to use domestic regulations and standards as "unnecessary obstacles to international trade" (WTO 1995). The TBT specifically contains provisions encouraging countries to harmonize their standards and rely whenever possible on international standards as a basis for domestic policies.

Because international trade law encourages countries to rely on international standards, this gives international businesses as well as national governments a strong reason to participate in international standard setting. In the United States, the NTAA calls for NIST to take steps to ensure that the interests of U.S. businesses are sufficiently represented in international standard-setting processes. Other governmental entities, such as the Office of the U.S. Trade Representative (USTR) and the U.S. Agency for International Development, actively monitor and coordinate efforts to promote U.S. interests in standards development processes (USTR 2022). In addition, representatives from major federal agencies participate in a government-wide Interagency Committee on Standards Policy (ICSP) in an effort "to promote effective and consistent standards policies" across the federal government, as well as to "foster cooperation between government, industry, and other private organizations involved in standards activities" (ICSP 2021). Given the significant trade implications that standards can have, other countries' legal and

administrative bodies are similarly active in international standards development.

CRIMINAL LAW

In discussing the interaction of standards and law in each of the preceding domains, it has been presupposed that standards apply to private businesses and their products and services, which they mainly do. But standards can also apply to governmental bodies. Specifically, standards play a key role in the criminal courts of the United States by helping ensure the accuracy of forensic evidence presented to juries.

ASTM International has developed a comprehensive set of more than 60 forensic science standards on the storage, testing, and analysis of evidence (ASTM 2023). Courts now use conformity with ASTM standards to determine whether expert testimony on forensic evidence is admissible in criminal trials (*United States v. Weiss*).

In a pivotal case on DNA analysis, the Minnesota Supreme Court held that the admissibility of laboratory results in criminal cases ultimately "hinges on the laboratory's compliance with appropriate standards and controls" (*State v. Schwartz*). Today, standards' conformance with respect to laboratory techniques and operations is pivotal for forensic laboratories to receive accreditation.

Ensuring that forensic science standards are kept up to date is critical when courts mete out criminal punishments. Unfortunately, wrongful convictions remain a serious problem in the United States. The continued development of, and conformity with, state-of-the-art forensic science standards offer one avenue for minimizing error in the legal system.

CONCLUSION

Given the numerous ways that standards intersect with the legal system, it is important for lawyers, engineers, and other professionals working with both worlds (standards and

law) to understand each other and communicate effectively.

Unfortunately, lawyers historically have received far too little exposure to standards in their professional training (Kanevskiaia 2020; Coglianese and Raschbaum 2019). The Penn Program on Regulation (PPR) has sought to rectify this gap in legal education by developing, with support from NIST, a suite of curricular materials for use in law and policy courses. These materials, which are freely available at www.Codes-and-Standards.org, include a wide range of case studies, teaching guides, videos, slides, and references (PPR 2022).

Projects such as www.Codes-and-Standards.org provide resources to make it easier to educate legal professionals about the important work of standards professionals. After all, standards, like law, help govern business practices and product designs. They both can perform critical governance roles in today's economy. Indeed, standards arguably may be more important today than law in governing the fast-changing digital technologies that increasingly affect all our lives, such as artificial intelligence (Wallach and Marchant 2019). Rather than seeing law and standards as two separate worlds, we can and should see them for what they are: two intersecting and often complementary worlds.

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