



Six Ways to Apply Ergonomics in Design

By Josh Kerst, CPE, CIE

About Humantech

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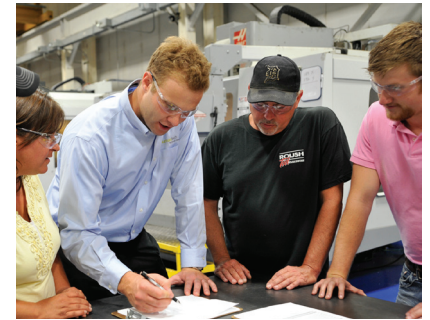
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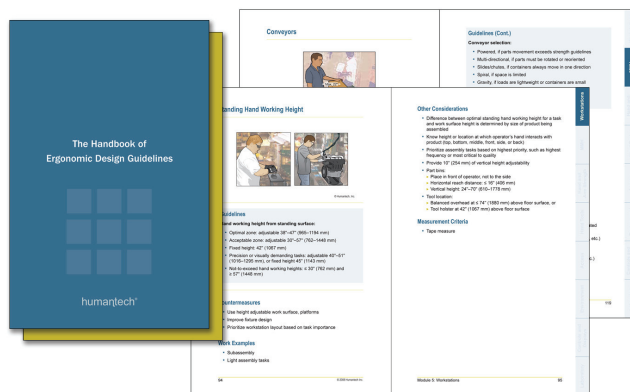
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About Josh

Josh Kerst, **Vice President** and **Ergonomics Engineer** for Humantech, has over 25 years of experience designing ergonomic work cells, assembly lines, tools, fixtures, and office environments. He has provided technical design services, established ergonomic design standards, and conducted conceptual design reviews in a wide variety of industries.

At Humantech, Josh has conducted design projects in environments including automotive, aerospace, rail and truck transportation, pharmaceutical, consumer goods, food processing, oil and gas production, janitorial services, and offices. He has worked closely with both product and facility design teams to develop innovative waste/recycling collection vehicles, petroleum transportation tankers, medical IV bags, and syringe designs. Josh led the ergonomic design team in support of a billion dollar aluminum smelter project in Iceland, and has also served as the lead ergonomics consultant on the Swiffer® product development team.

Josh received the Medical Design Excellence Gold Award for the design of NuStep's T5XR cardiac rehabilitation device. He published the "Ergonomic Factors in Laboratory Design" chapter of the Handbook of Chemical Health and Safety and has published "Ergonomics Issues in Laboratory Animal Handling" for the Proceedings of the National Academy of Sciences.

Josh obtained a Bachelor of Science degree in Industrial and Operations Engineering from the University of Michigan. He has gained professional recognition as a Certified Professional Ergonomist (CPE) and as a Certified Industrial Ergonomist (CIE). He serves on the Ergonomics for Children in Educational Environments Technical Committee for the International Ergonomics Association.



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About this E-book

My job as an ergonomics engineer and design consultant has provided me with a wealth of experiences unlike any other. On a regular basis, I am engaged in process, workplace, and product design teams from a wide array of industries that can range from extremely large systems to very small applications. Every project is unique, but I regularly make note of what consistently works well, and document what doesn't work. Either way, I'd be hard pressed to trade those global experiences for any other educational substitute.

Engineering design is a strong determinant of workplace ergonomics. I've seen efficient and effective design approaches add extreme value to a business by engaging the workforce and improving the company's productivity and bottom line. However, I've also witnessed many others that are frustratingly poor, rely on heroic efforts, are overly cumbersome, and can ultimately deny workers their health, safety, and even morale.

This e-book can help if you are facing the challenge of integrating ergonomic design to improve the way people work at your company. Good ergonomic design principles apply to product design, workstation design, machine tool specification, and even space planning. In this e-book, I focus mainly on workplace and workstation design challenges.

I've distilled the essential ergonomic design considerations down to six simple practices demonstrated by companies of all sizes, industries, and locations. While this guide describes what to do, I also include "potential pitfalls" so you can avoid making these same mistakes when it comes to driving real improvements in your workplace.

But let's not stop there. I invite your comments, questions, and reactions to this e-book on our blog, [The 30-Inch View](#). And if you enjoy what you read, please feel free to share it with colleagues and co-workers.

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Introduction

Technological advances over the past decade have been unprecedented. New technology has made our world more convenient and efficient and it's moving at an ever-accelerating pace. The desire to harness, utilize, and deliver new technologies creates a natural linkage to ergonomic design. And, while many tasks and processes are now mechanized or automated, many are still performed manually in many industrial settings. Matching operator abilities with task requirements, as well as with the working environment and physical constraints, are critical aspects to be managed within effective workplace design.

People expect new things to work right, feel right, and meet their expectations straight out of the box. To quote Apple's customer commitment, "It just works." Users expect engineers to deliver enhanced tools, equipment, and workstations that are easy to use and that help them do their jobs better. Designers are thus indelibly linked to ergonomics by this increased demand for proper design in the workplace.

It seems reasonable that engineers and designers would deploy a systematic process to meet their users' expectations and be literate in the essential ergonomic design principles so that they might seamlessly integrate them into their projects. But this isn't always the case and, in fact, many design situations arise at companies that are downright baffling.

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Here's a recent example I fondly call "Rosie's story." I was asked to work with a component supplier to improve the ergonomics of their new assembly line. This was the company's second attempt to introduce the new line; the first one was a disaster. Everyone suggested I begin by speaking to Rosie, one of the most senior employees on the old assembly line. I asked Rosie how it was going and she stated frankly: "I'm completely frustrated. I've been a conscientious team member at this company for longer than most of these pimple-faced engineers have been alive. I volunteered my time to be the ergonomics representative and our team diligently noted all the existing risk factors for our old assembly line. We sent our suggestions to EHS and we hoped that the new line design was going to be better. Instead, everyone is looking at me because many of the same problems are still here. We can't meet our production rate and some tasks are even worse than before! My fellow line workers must think I lied to them. How can this be?"

Rosie's story is a perfect example of how good intentions can yield poor results if the proper steps are not taken to systematically integrate ergonomics into the design cycle. A closer review of the missteps in the project revealed some flaws:

- **Lack of ergonomic design standard/requirements.** No design standard and no regulatory requirements (state, province, or country) lead to design variability in the workplace.
- **Low knowledge of risks.** People don't know what they don't know. Enough said.
- **Project constraints.** Projects move along tight timelines, and many early decisions lock in equipment and introduce constraints. Rosie delivered the report recommendations to the project team but not until well after all equipment and designs were finalized and procured.
- **Inefficient system design.** Ergonomics is best managed as an engineering function. Rosie's team delivered the report to the EHS representative who didn't have adequate clout with the project engineering team and didn't integrate well or use the language of their current design system.

So how do companies prevent situations like the one Rosie experienced? Following are the six ways to design in ergonomics.

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Establish Ergonomic Design Specifications

Almost every organization has built-in safety procedures to prevent the introduction of known hazards into its workplace when new equipment, tools, and materials are purchased or modified. These systems usually include things like Material Safety Data Sheets (MSDS), lock-out/tag-out (LOTO), machine guarding, fire safety, and many more. However, there are limited regulatory requirements or standards that specify ergonomic design attributes. Surprisingly, few companies have taken the proactive step to translate ergonomic design features into purchasing specifications to control the flow risk of the workplace. Too often “hazard” and “risk” are used interchangeably, so it’s not unreasonable for designers to say they can’t be expected to design out all hazards. What they overlook is that by reducing exposure to those hazards, the goal of eliminating the associated ergonomic risk is within easy reach.



The situation can get really confusing when companies are not specific about ergonomic design requirements. Successful companies establish internal design standards and guidance references to give design teams and suppliers a reference indicator they can proactively measure and track. Communicating this specific information can demystify what is meant by an ergonomic design while supporting the reduction of MSD risk factors and improved design.

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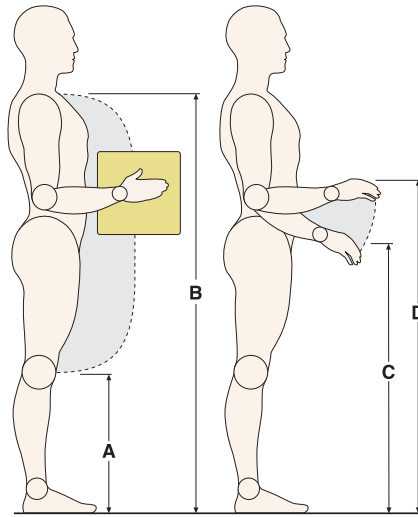
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Design specification best practices include the following:

- A “simpler is better” approach for engineering standards and design references. Use reference wikis that are concise and highly visual.
- Global anthropometry considerations (North America, Europe, Asia, Latin America)
- Dimensions and ranges that support adjustable and reconfigurable designs (to accommodate neutral postures and varying tasks)
- Minimized manual material handling requirements
- Environmental considerations like lighting, temperature, noise and vibration
- Accommodations for older workers



Product manufacturers will often describe their equipment as “ergonomic” when, in reality, no study or objective verification has been conducted to support those misleading claims. Don’t rely on suppliers to tell you that their products and equipment are ergonomically designed. This approach can lead to mistakes, unclear expectations, and ultimately, injuries. Ergonomic design criteria are defined and measurable.

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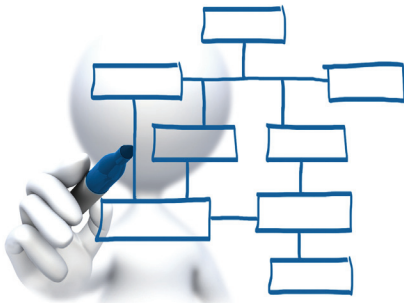
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Educate the Engineering Team

Most engineers are not aware of the degree to which they influence the work environment of other people, so they typically do not integrate ergonomics considerations into their engineering projects. Surveys among engineering societies confirm that ergonomics frequently gets a low rating among engineers in terms of importance in design. How is this possible?



First of all, it's not all the engineer's fault. We need to dispel the myth that engineers carpool together each weekday thinking up punishing jobs for people to perform. The stark truth is that these conditions exist because neither management nor safety organizations express any expectations in this area. The education experiences in ergonomics training and the follow-on effects in engineering schools are also very limited. Engineers can get a Bachelor's, Master's, and PhD degree in engineering and never take a class on people. Astounding! As the saying goes "You don't know what you don't know," and it certainly applies when speaking about ergonomic design elements for engineers.

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Ergonomics engineering education best practices include the following:

- Require designers to perform the jobs they create. Engineers learn best by doing and connecting the dots through experiential learning works. Humantech's [benchmarking results](#) revealed that the best ergonomics programs require technical staff to participate in “ergonomics days” during which engineering and line staff work shoulder to shoulder at least annually.
- Develop a common language between ergonomists and engineers. Provide education to both groups to understand each other’s language, terminology, and approaches to design.
- Build in educational expectations right from the start when engineers join the company. Supply them with ergonomics information, principles, and data for which they will be responsible, and link courses to their respective tasks and design team roles.
- Require your suppliers to do their part and complete technical ergonomics training.



Remember, technology is advancing at a phenomenal rate. Allowing engineers to waive proper ergonomics training because they had a class or two in college is a mistake. Design engineers may perceive ergonomics information to be of minor importance, so make the value statement clear and hold people accountable.

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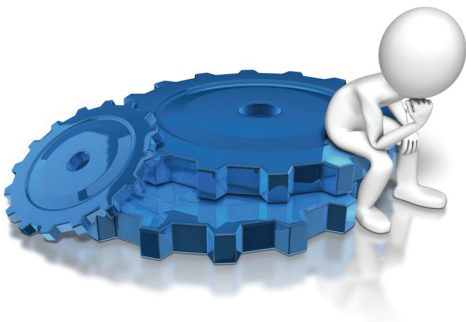


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Manage Constraints

Ask any one of your designers if there are any people in their latest design prints or CAD drawings. If they answer no, ask them “Then how do you know that you have accounted for the production employee’s needs?”

Experience has shown that the design process is driven by constraints. The best solution to a design problem requires navigating and negotiating the constantly changing tug-of-war across the constraint battlefield. It is hard to argue and negotiate for what you cannot see or measure. Hence, inserting a visual representation of people into drawings is a great start. Even a static drawing that includes a blue-line overlay of a small and large person illustrates their acceptable working ranges. This design aid highlights potential concerns like a tall person bending over to work at a low workbench and a small person stretching to reach a high shelf.



Of course, there is more to constraint management than just putting people in drawings; ergonomists must negotiate their design priorities along with those of other designers. The three biggest constraints usually bubble up: people, time, and money. Frequently, cost and time constraints in engineering projects are observed as factors that may hinder organizations from taking ergonomics into account. So, for ergonomists, it is an important skill to be able to “sell” ergonomics to management based on cost justification. The better ergonomists are at balancing these constraints and solving design problems, the more impact they will have on the final design.

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To positively influence constraint management issues:

- Include both large and small anthropometrically accurate people in drawings to highlight design boundary issues.
- Deliver support tools with which the engineer is acquainted, for example, provide scalable human images that can be integrated into CAD systems, access to ergonomic reference criteria, and even libraries of good design drawings.
- Offer design alternatives and suggest an array of cost-effective options during the design process.



Avoid “design amnesia.” Engineers tend to rely heavily on previous design because of perceived effectiveness and time savings. The role of the ergonomist is to work as a change agent to keep past design issues fresh in everyone’s mind and to suggest alternative options when trying to integrate ergonomics into engineering constraints.



#4

Leverage Existing Design Systems

The truth is that most engineers are insulated from the consequences of their designs regardless of whether they are good or bad. When things go bad on delivered designs, I've frequently heard engineers say that the failure was the result of operator error. I disagree. We refer to these failures as "error provocative" designs. Humantech's [benchmarking studies](#) clearly demonstrate that leading organizations require engineers to utilize ergonomics principles and structure their reward systems to encourage their use.

Occasionally, an engineer will overcome the absence of a fully-integrated ergonomics system and demonstrate heroic effort to deliver improved ergonomic designs. Instead of being rewarded or acknowledged for his or her efforts, organizational politics can put that same designer on the defensive for going beyond scope, wasting time and money, or taking a rogue approach.

The best closed-loop systems integrate well-functioning efforts from other areas within your organization. Ergonomic assessment teams can be a great resource to share risk severities and pinpoint root causes for risk in specific designs. Production bottlenecks, quality concerns, and even absenteeism data can also provide valuable insights into areas that need improvement. The key is to leverage what already works in your company and link it to ergonomic design.



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Here are some ways to integrate ergonomic design with existing systems:

- Include ergonomic design criteria as part of your current design process.
- Develop easy-to-use protocols and audit measures to link standards, training, and design reviews for new and modified equipment.
- Include phase gate reviews at critical junctures in development.
- Have an ergonomics subject matter expert participate as a member of the cross-functional engineering design team with specific tasks in the different phases of the design process.
- Use front-line ergonomics teams and operators to summarize the severity of and root causes for current risks in similar operations or previous designs.
- Link root causes and quality concern data to workstation design risk factors to guide design rules and opportunities.



Ergonomics standards are often ignored by design engineers. The Royal Navy had a wonderful saying that applies here: “People tend to respect what they expect you will inspect,” from which came the simpler “People don’t do what you expect—they do what you inspect.” Create accountability and act on it accordingly.

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Right Questions to the Right People

Ok, this all sounds good, but how do I actually do this stuff? Simple. Facilitate an ergonomic design review (EDR) meeting to screen the design for ergonomic acceptability. This requires that you ask the right questions of the right people at the right time, so design teams can proactively negotiate alternatives. An EDR is an essential tool that assists the design team in proactively considering ergonomics, summarizes potential risks, and lists opportunities for managing any identified concerns.

An EDR should be facilitated by someone with ergonomics competence. The activity requires assembling the **right people**, usually a cross-functional team that has representation from the project team, engineering, quality, production, EHS, ergonomics subject matter experts, and experienced operators.

An ergonomic design review checklist should be completed early in the life of the project. The **right time** is after conceptual design and prior to completing the basic engineering (schematic design) phase of the project. Site plans, floor plans, and equipment lists should be mostly complete and available for review, and the EDR should be completed before detailed designs are finalized.

The **right questions** are typically an inventory of known risk factors, industry-specific concerns, or design rules that have been identified by historical data, trend analytics, and experience. These should be concise questions with “yes” or “no” answers based upon measurable design criteria.



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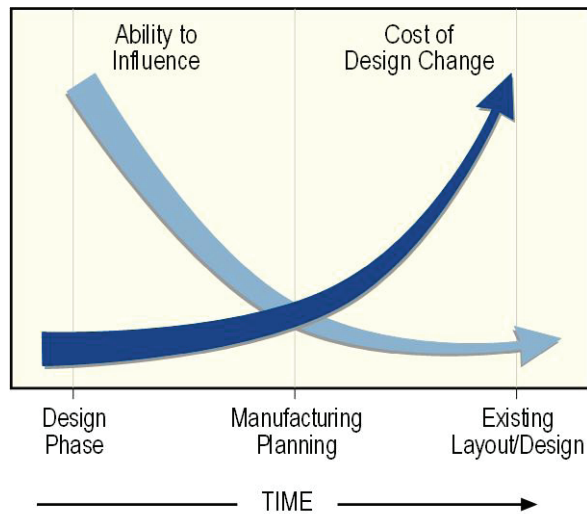
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Here are some best practices for ergonomic design reviews:

- Involve key stakeholders in the design, as well as experienced operators.
- Develop company-specific ergonomics questions driven by your analytics.
- Summarize EDR results and produce actionable plans.
- Document your decisions and incorporate findings.



Avoid Monday-morning quarterback design decisions and don't be late to the party. Conceptual and basic design phases are the best times to get involved with design.

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Validate Designs, Share Success

This last element requires verifying that ergonomic risk has been successfully managed to the lowest level possible through the delivered design. A follow-up EDR checklist should be completed and the action plan reviewed for any outstanding issues. Documentation should be filed and key lessons learned should be recorded.



Companies are discovering that many ergonomic challenges are similar across different departments, locations, or business units. This should come as no surprise, as limits of human performance do not vary greatly, regardless of where the tasks are performed. By taking the time to share design improvements, whether via company conferences, web sites, or just plain networking, we can accelerate the ergonomics initiative, and spend more time replicating improvements and less time assessing challenges. This technique is known as FORM, or Fix Once, Repeat Many. The FORM approach to ergonomics

problem solving is most effective when supported by common analysis techniques and centralized access to solutions. This is why companies are finding that enterprise-wide ergonomics initiatives can help them achieve sustained success with an emphasis on sharing solutions.

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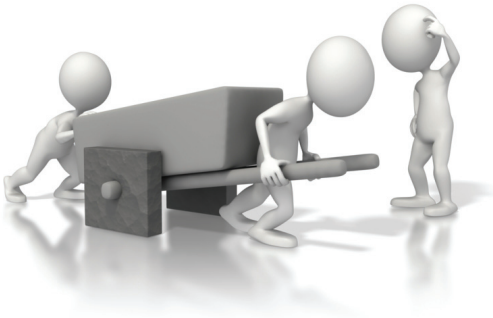
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Here's a summary of key activities:

- Complete follow-up assessments.
- Practice the FORM technique.
- Leverage technology by tracking design successes in a database.
- Promote and share success stories using in-house broadcast mechanisms.



Avoid reinventing the wheel with each design project or, worse yet, replicating bad designs. If organizations only knew what they have already learned, they'd have most of their ergonomics issues addressed by now. Share the experiences, good and bad, and learn as an organization.

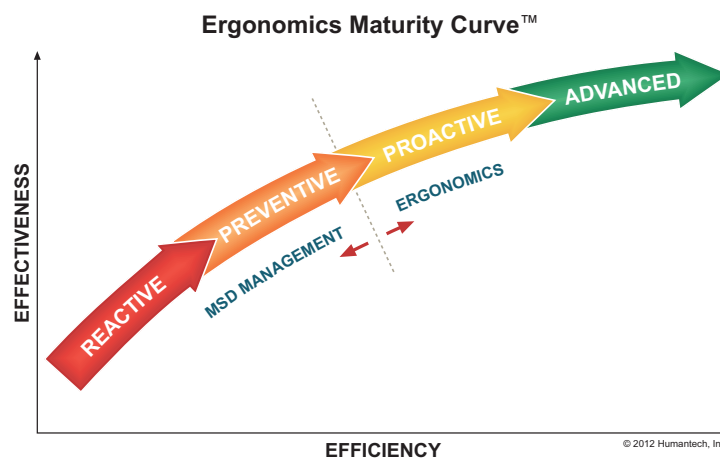


Final Thoughts...

So, now you're probably thinking: "Wow, this seems so simple and straightforward. Why has it been so hard to get this accomplished at my company?" Don't despair. Lots of companies have made improvements by adhering to these six simple practices. I hope you've found this e-book to be a good starting point for extending your discussions with engineering, and that you've come away with some fairly common-sense and practical ideas.

Simply put, if your company wants to be more effective and efficient, it needs to proactively deliver products and processes that are ergonomically designed right from the start. Start by developing a standard, educate your engineering team on its value, and then integrate it throughout your design process, from concept to commissioning.

Moving up the Ergonomics Maturity Curve™ establishes a trajectory for a lasting basis for successful ergonomics. Taking these six practices into consideration and understanding your engineering culture can provide a good launching point for reshaping your organization to become more open to ergonomics and, ultimately, to support better engineering.



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Additional Resources

We've compiled the following resources to help you take the next step toward a successful ergonomics process:

- [Case studies](#). Browse through some impressive results in safety, quality, delivery, and cost, from Humantech clients.
- [Five Mistakes Companies Make with Ergonomics](#). This free e-book covers the five most common mistakes to avoid when establishing an ergonomics process, shares keys to success, and includes links to many useful references.
- [Archived webinars](#). View recent recorded events presented by board-certified professional ergonomists and trainers covering topics like top 10 design rules for ergonomics, justifying ergonomic improvements, sitting versus standing, and warehouse ergonomics.

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