

# ERGONOMICS RISK FACTOR MATRIX™

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Problem solving is a fundamental part of ergonomic analysis. There are many tools available to the Ergonomist to assist the employer with identifying ergonomic risk factors and targeting them for change. Many of these tools were derived from university research and most have been validated to some extent over the years. They include, but are not limited to:

- NIOSH Lifting Formula.
- Rapid Upper Limb Assessment
- Strain Index.
- Rapid Entire Body Assessment.

As a consultant, I am constantly looking for ways to assist my clients with simple and effective methods to resolve their safety, production and quality concerns. Recently, one of my clients asked me to develop a “tool” that would help their supervisors be better prepared to assist employees with modified duty work activities. Much of the work at the client location was repetitive and the supervisors were having a hard time knowing which tasks may create increased risk of aggravating employees with repetitive motion injuries (RMI). They needed a tool that would answer the question, “How much is too much when it comes to repetition and force?” This is the age-old question that ergonomic academicians and practitioners have been trying to answer and I accepted the challenge to develop a tool that would help them to better define work rest cycles for injured and non-injured employees.

As I searched for an answer, I came upon a commonly known theory in the consulting world known as 2 x2 thinking which is considered universal and highly transferable. The approach takes a complex situation and models it as a set of dueling interests, often in conflict with each other. In place of a single right answer, a set of plausible options is created by considering high and low cases of the two conflicting needs. 2x2 thinking is documented in the book, *“The Power of the 2 x 2 Matrix: Using 2 x 2 Thinking to Solve Business Problems and Make Better Decisions”* by Alex Lowy and Phil Hood<sup>1</sup>. 2x2 thinking is extremely flexible and can be used for personal problem solving to large strategic conflicts. My client’s main concern was regarding the exposure to forceful and repetitive tasks. For them, it was essential to establish options to help manage employee work-rest cycles so as not to aggravate existing injuries.

The 2x2 matrix is simple and innocent in its application, yet powerful in its outcome. As discussed in Lowy and Hood’s book, a set of master principles of practice must be present for the 2x2 matrix to work. They include:

- **Struggle:** the issue must be one that has been hard to resolve so that it is ripe for change and new insights.
- **Timing is critical:** the most complex situations benefit from the 2x2 model if the timing is right.

- **Simplicity:** when mapping complex and highly charged material, simplicity is vital to preserve the concept as stable and reliable. It makes it intuitive to apply and easy to communicate to others.
- **Ownership:** the greatest value comes from active participation in developing and interpreting the matrix.
- **Commitment:** developing the matrix requires accountability, passion and personal investment in the outcome.

The 2x2 model is a medium and device to achieve an important outcome. It serves as a conduit to focus on the issues and the conflict to derive clarity in the outcome.

The structure of the 2x2 matrix creates the possibility of looking beyond the restriction of either/or perspective by placing conflicting items in dynamic relationship to each other. It offers four possibilities creating an outlet where there previously was all or none. This in itself is a vital step towards more successful problem solving and decision making.

The 2x2 matrix is about as simple as a chart can be. The matrix includes two factors that have some relationship with one another, assign one the horizontal axis and the other the vertical axis. The use of intersecting x (horizontal) and y (vertical) axis are present in all 2x2 modeling and is the basis for statistical methods from t-test to multivariate factor analyses. Statistics are used to classify, qualify and measure relationships. The simple matrix grid allows the comparison of different states of related items to reveal patterns, convert quantitative into qualitative value or numbers to meaning. The simplicity of the 2x2 matrix allows it to be intuitive to apply and communicated easily to others. At the same time, the matrix is limited to a single issue which is dynamically defined by 2 prime opposing forces. This makes 2x2 thinking highly adaptable to many situations.<sup>2</sup>

The Ergonomics Risk Factor Matrix™ (ERFM) shown in Table 1, is an example of 2x2 thinking in that it takes a fundamental issue of “how much is too much exposure” and identifies two primary culprits that often are found together in task performance; repetition or sustained exertion and force. The matrix is presented as a guide to modify tasks with high force and/or repetition. Repetition is on the x-axis and force is on the y-axis. Duration (how long the task occurs) and frequency (how often the task occurs) are strong predictors of the likelihood of a cumulative trauma disorder (CTD). The longer the task occurs, the more frequently it should be modified to reduce exposure.

The matrix does not take into account the employee’s working posture. If posture is awkward, correct with engineering changes or education so that the employee is working as close to neutral as possible. If posture is sustained for more than 45 minutes, consider it a sustained exertion or high repetition. In using the matrix, high force may be identified as a perceived exertion by the employee.

## Ergonomics Risk Factor Matrix™

		<b>Repetition/Sustained Exertion</b>					
		Low		High			
<b>Force</b>	High	<b>If the task occurs:</b> One time every 5 minutes or greater  <b>Then:</b> Occasional to frequent exposure through the day.		<b>If the task occurs:</b> One time every 15 seconds to every 2 minutes  <b>Then:</b> Interrupt every 15 minutes for at least 2-3 minutes	<b>Force</b>	High	
	Low	<b>If the task occurs:</b> One time every 5 minutes or greater  <b>Then:</b> Continuous Exposure		<b>If the task occurs:</b> One time every 15 seconds to every 2 minutes <b>Then:</b> Interrupt every 30 minutes for 4 minutes or every 60 minutes for 10 minutes	<b>Force</b>	Low	
		Low		High			
		<b>Repetition/Sustained Exertion</b>					

Table 1. The Ergonomics Risk Factor Matrix™ places force on the Y-axis and repetition on the X- axis.

Work activities associated with high force include, but are not limited to:

- Pipette use: manual or pipette aide.
- Pinch or grip: to cap/uncap, open test tubes, flasks or bottles.
- Items manually handled that weigh greater than 5 pounds.
- Items lifted weighing greater than 17.6 pounds.
- Manual pointing device use.

Furthermore, time allocation definitions<sup>3</sup> are used to identify the duration or how much repetition is occurring and if it should be modified relative to force. Table 2. below is helpful to define time on task and exposure.

Definition	Percentage of Shift	Of 8 hour Work Day
Never (rarely)		
Limited	Less than 12% of time on shift	Up to 60 minutes
Occasionally	Up to 33% of time on shift	Up to 2 ½ hours or 1x/hr
Frequently	Up to 66% of time on shift	Up to 5 1/2 hours or <a href="#">1x@2 min</a>
Constant	67%-100% of time on shift	Up to 8 hours or <a href="#">1x@15s</a> or less.

Table 2. Time Allocation Definitions

Below is a list of common tasks that are performed frequently in many workplaces. By using the Matrix, the level of force and repetition are determined as well as how the task could be modified to limit exposures. The matrix helps to identify the relationship of force to repetition by delineating time on task and acceptable exposure or duration. It then indicates the appropriate level of exposure followed by an interruption. The interruption could be considered a micro-break, alternative task or interruption of stretching or simply postural change. In most cases, these “breaks” last from 1-10 minutes before resuming the primary task at hand. It is recommended that for every 30 minutes of a highly repetitive/forceful task, at least a four minute interruption is taken and for 60 minutes, at least ten minutes of interruption performing an alternative task that uses different muscle groups before resuming the primary task.<sup>4</sup>

<b>Task</b>	<b>Force</b>	<b>Repetition</b>	<b>Modification</b>
<b>Typing a report at the workstation for 4 hours.</b>	Low	High	Interrupt every 30 to 60 minutes for 5-10 minutes.
<b>Low level reaching in/out of shaker occurs for 5 minutes every 3 hours.</b>	Low	Low	Continuous. No modification necessary.
<b>Manual pipette use to split cells, up to 40 T175 flasks for 4 hours.</b>	High	High	Interrupt every 15 minutes for up to 2 minutes or greater.
<b>Sitting at a fixed height Biosafety hood for 4 hours using an electronic multi-channel pipette.</b>	Low	High	Interrupt every 30 to 60 minutes for 5-10 minutes
<b>Mousing at the computer to complete a database for 3 hours.</b>	High	High	Interrupt every 15 minutes for up to 2 minutes or greater.

The examples above could be debated as to the actual force required relative to repetition. Feedback by employees as to the perceived levels of exertion is essential in using the matrix to assist with defining work rest cycles and work modification. In particular, recognizing the impact that a pre-existing or chronic musculoskeletal disorder might have on the employee or one with a recent diagnosis of a cumulative injury verses a healthy employee with no prior history of aggravation or injury.

The Ergonomics Risk Factor Matrix™ demonstrates the power and simplicity of 2x2 thinking. It identifies the issue of exposure and two dynamically opposed components, force and repetition, that result in a means to solve a fundamental problem and make better decisions to modify work rest cycles. The 2X2 matrix cannot cover all possible confounding factors such as variety of tasks, cycle times within confined periods, individual differences of people, but it does give the practitioner a place to start. The ERFM is what it is, it does not address any more than these two factors, yet it results in opportunities beyond either/or. It is a simple model that explores the relationship of force

and repetition, giving employers options to modify work tasks for a safer work environment for all employees.

References:

1. Lowy, Alex and Hood, Phil, *The Power of the 2x2 Matrix: Using 2x2 Thinking to Solve Business Problems and Make Better Decisions*, John Wiley and Sons, Inc. 2004.
2. Lowy, Alex and Hood, Phil, “2X2 Modeling and Problem Solving: Part One”, Consulting to Management, Journal of Management Consulting, Inc., Wisconsin, USA, Vol. 15, Number 3, September 2004, pg. 27-36.
3. Dictionary of Occupational Titles, US Department of Labor, 1991.
4. Balci, R., Aghazadeh, F., Waly, S., “*Work-Rest Schedules For Data Entry Operators*”, Dept of Industrial Engineering, LSU, Baton Rouge, LA. *Advances in Occupational Ergonomics and Safety*, S. Kumar, IOS Press, 1998.

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