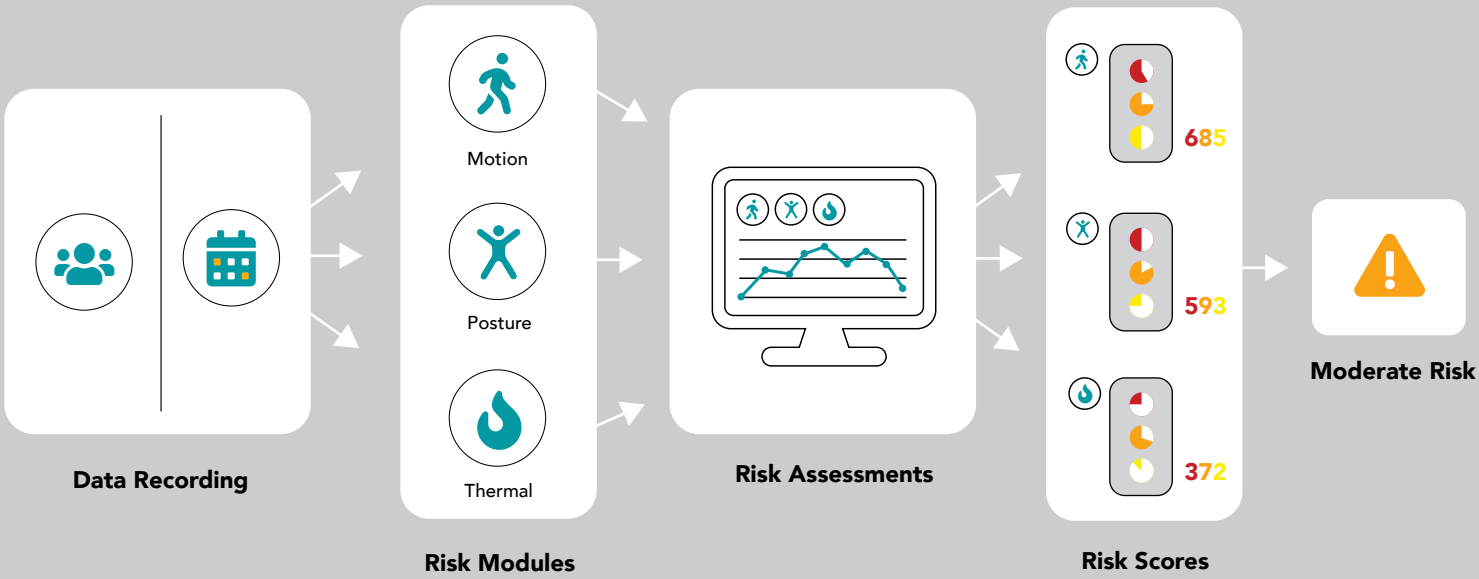
LIFEBOOSTER

WHITEPAPER BY LAWRENCE CHEE & JESSICA ZENDLER

A Guide to LifeBooster Senz™ Ergonomic Risk Scoring

The LifeBooster Senz analytics platform applies a building block approach to assessing ergonomic risk exposure. It utilizes data recordings, risk modules, risk assessments and risk events to produce a risk score.



Data Recording

Data recording occurs when a worker wears Senz sensors for a continuous work period, up to 14 consecutive hours. Recording begins when the sensors are removed from the charging cradle (dock) and continues until they are returned to the cradle at the end of the day or assessment period. Senz sensors are multi-functional, so they can be used for any type of risk evaluation. Senz sensors are able to assess upper body motion, posture, experienced thermal conditions (heat stress risk) and hand-arm vibration simultaneously. Senz wearable sensors, which are designed and manufactured by LifeBooster, are ruggedized to survive industrial environments.

Risk Module

A risk module, or application, is a set of algorithms used to evaluate risk exposure for a specific risk type (Table 1). The algorithm is closely associated with one or more related ergonomic standards. Depending on the complexity of the standard, it may have additional risk sub-types. The risk module is applied to each data recording to produce a risk assessment.

Table 1. Senz Risk Modules and Associated Risk Types

Risk Modules	Risk Type	Risk Sub-Type
ErgoSenz Motion	Repetitive Strain	Left Elbow Flexion/Extension Left Shoulder Inclination Right Elbow Flexion/Extension Right Shoulder Inclination Back Flexion/Extension Back Lateral Flexion/Extension Back Rotation
ErgoSenz Posture	Sustained Postures	Left Shoulder Inclination Right Shoulder Inclination
ErgoSenz Vibration	Hand-Arm Vibration	Left Hand Vibration Right Hand Vibration
EnviroSenz Thermal	Heat-Related Illness	

Risk Assessment

A risk assessment is the result of applying a risk module to a single data recording. These can be expressed as daily assessments (the risk exposure of a worker for a given day) or as task assessments (the risk exposure of a worker for a given task). Risk assessments can also be viewed over an extended period of time to understand trends. This is viewable both on an individual worker basis or by job type, location, risk type. Multiple risk assessments can be viewed for comparative analyses.

Risk Events

Risk events are moments in time in which a risk, due to the presence of one or more risk factors specific to the risk type, is declared. Risk events are color-coded to quickly convey the relative magnitude of risk exposure using the common convention of green, yellow, orange, and red to indicate increasing risk, similar to ISO 11228-2:2007 with the addition of orange (Table 2). The criteria for a risk event are specific to the risk (sub)type and are based on the foundational ergonomic standard(s). Note that all moments are considered implicitly to be green events until a yellow, orange, or red risk event is declared. Risk events are the foundation of the Risk Score and related analytics.

Table 2. Risk Event Colors and Interpretation

Risk Event Color		Interpretation
Green		Acceptable Conditions
Yellow		Conditionally Acceptable
Orange		Requires Immediate Attention
Red		Not Acceptable

Risk Score

Senz computes a three-part Risk Score (Table 3). The Risk Score helps the assessor to determine:

- the order of magnitude of risk exposure (quantification)
- the risk type(s) (identification)
- the trends of risk exposure requiring action (prioritization)

The three parts of the Risk Score are the Risk Events Count, Risk Severity, and Total Risk. Each risk (sub)type will have its own Risk Score. The following sections explains each component in more detail.

Table 3. Senz Tiered Risk Score

Risk Score	Definition	Application	Comparability
Risk Events Count	Number of (yellow, orange, red) risk events for a risk type	Provide an order of magnitude in the number of risky occurrences and identify which risk types within the risk module demands the highest attention	Between tasks within a risk assessment
Risk Severity	Normalized, 3-digit representation of the Red, Orange, and Yellow Risk Events Counts for a risk type	Identify trends of risk exposure for a risk type or risk module	Across risk assessments
Total Risk	Number of risk (sub) types that have at least 1 red risk event	Identify which risk type is most prevalent across a set of risk assessments	Across risk assessments and risk modules

Risk Score: Risk Events Count

The Risk Events Count represents the number of risk events for each risk level of yellow, orange, and red, within a single assessment. It is used to quantify risk type and magnitude. Risk Events Counts are aggregated by risk (sub) type. Risk Events Counts provide:

- relative magnitude of risks between risk types within the same risk module
- relative magnitude of risk exposure between different tasks for the same risk type
- relative magnitude of risk exposure between the same task performed over time for the same risk type

Note that Risk Events Counts between different risk modules are not comparable, because each risk module is based on a different ergonomic standard, and risk interpretations within standards may not be equivalent. For example, a count of 30 yellow risk events for right hand-arm vibration identified by the Vibration risk module cannot be considered equivalent to 30 yellow risk events for right shoulder inclination identified by the Posture risk module. Additionally, Risk Events Counts are comparable between different risk assessments made with the same risk module only when the duration of the risk assessments are identical.

Risk Score: Risk Severity

The purpose of the Risk Severity is to allow the assessor to evaluate the relative magnitude of risks between different assessments for the same risk type. Risk Severity is a numeric value with a range of 000 to 999 that is directly related to the Risk Events Counts, and it accounts for differences in recording duration through a process called Risk Normalization to achieve meaningful comparisons across assessments.

Risk Normalization is a two-step process. First, the Yellow, Orange, and Red Risk Events Counts are adjusted to represent an 8-hour period, when an assessment is shorter than 8 hours. This is done for each risk type and risk module separately. If an assessment is longer than 8 hours, the actual Risk Events Count values are used. Second, the 8-hour Adjusted Risk Events Count is converted to a value from 0 to 9, with 0 being least severe and 9 being most severe. The Adjusted Risk Events Count for each color is divided by a coefficient (Risk Divider) that is specific to the risk type and risk color. The coefficient is derived from examining actual Senz data and determining an appropriate representation from minimal to most dire risk exposure. The value is rounded up to the nearest whole number and any values exceeding 9 are capped at 9. The equation below is written for the Red Risk Digit, but the same formula can be used by replacing Red with Orange or Yellow.

$$\text{Red Risk Digit} = \text{minimum}\left[9, \text{ceiling}\left(\frac{\text{Red Adjusted Risk Events Count}}{\text{Red Risk Divider}}\right)\right]$$

Risk Severity is determined by merging the Red, Orange, and Yellow Risk Digits into a single number. The most significant (furthest left) digit is the Red Risk Digit, followed by the Orange and Yellow Risk Digits.

$$\text{Risk Severity} = \text{RedRiskDigit, OrangeRiskDigit, YellowRiskDigit}$$

Total Risks

This value represents the total number of different risk (sub)types that have at least 1 red risk event and is intended to support rapid prioritization for implementing control processes. For example, if an assessment has 8 Total Risks, it means that there are 8 different risk types that have each identified at least 1 red risk event within the time period covered by the assessment.

Risk Assessment and Risk Analytics Dashboards

Risk assessment dashboards provide graphical time representations of the Risk Events and Counts within a single recording. They are the primary interface for ergonomists and process engineers.

Risk analytics are graphical time and population representations of Risk Severity and Total Risk. They are used to identify trends and perform comparative analyses. These provide a high-level view of where potential problems may arise and are ideal for individuals in management roles to get a comprehensive picture of risk exposure within the organization.

Summary

The Senz platform is designed to seamlessly convert hours of sensor data into concise and actionable risk exposure information. Recordings from across the workforce are processed simultaneously through purpose-built risk modules addressing a wide range of risk types. Each module employs well-established external standards to identify and score risk events. Risk events are further aggregated and normalized to calculate the components of the Risk Score. This information is displayed on dashboards targeted to the needs of different users within the organization. The Risk Score summarizes and readily expresses the magnitude, type, and urgency of risk exposure. It is a relative marker for the necessity of action. Taken together, the Senz system enables effective and responsive ergonomic processes to improve worker health, limit injury-related losses, and enhance organizational success.

To learn more about Senz, risk scoring or connected worker technology, contact us at info@lifebooster.ca

About the Authors

Lawrence Chee is Co-founder and CTO of LifeBooster. He has 30+ years experience of developing novel technologies from chip development to cloud based analytics applied to areas spanning medical research to communication infrastructure and enterprise operations.

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About LifeBooster

LifeBooster is a connected worker risk analytics company. We optimize ergonomic risk reduction in the workplace by innovating sensor technology, smart garments, data science and business methods for industry professionals. Our predictive analytics platform, LifeBooster Senz™, assesses motion, thermal stress, posture and vibration from wearable sensors to detect elevated injury risk to workers due to behavior, work process and environmental dynamics. Senz visualizations, available anytime from any web-connected device, delivers a continual virtual presence on risk so professionals can design and implement powerful mitigation strategies. LifeBooster supports businesses of all sizes and the essential workers they employ across all sectors of the economy.

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