



Lowell Institute
for Mineral Resources

HARRY'S HAZARDOUS DAY GAME MECHANICS

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1. Objects

This document provides a redacted excerpt from the *Harry's Hazardous Day* Game Design Document (Section 2). It outlines the novel skills-based game mechanics framework under development for *Harry's Hazardous Day*. These game mechanics translate the knowledge, skills, abilities, and other attributes (KSAOs), outlined in the core competencies of our Mining Professional Competency Model, into game-specific challenges and achievements, as part of a novel role-playing character development experience. The Mining Professional Competency Model was developed by the Western Mining Safety and Health Training Center and is available at <<https://miningsh.arizona.edu/resources/competency-models>>.

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2. Game Mechanics

Hazardous Day models real-life activities in terms of simple yet interesting game rules. The game mechanics govern all aspects of user interaction with the virtual world and define the type and fidelity of tasks within this world, as well as advancement strategies. The game mechanics are by definition a *gamification* of the real world, rather than an attempt to precisely *simulate* the real world's irrelevant complexity. As such, the game mechanics should provide a useful abstraction to quantify behaviors that define competency and risk.

Our approach draws heavily on gamification techniques that have proven successful in the genre of Role-Playing Games (RPGs). The game mechanics of *Hazardous Day* are motivated by several classic RPG series, including *Dungeons & Dragons*, *The Elder Scrolls*, and *The Witcher*. For this discussion, the game mechanics have been segmented into two specifications covering the Character-relative and World-relative game rules. Each specification is outlined below.

2.1 Character Mechanics

In *Hazardous Day*, a "Character" is a unique human with distinct avatar, personality, and psychophysical attributes. Each character is assigned a set of game metrics (stats) which parameterize its abilities and boundaries. All interactions with the game world, inclusive of the environment, equipment, and other characters, are defined in terms of the character stats through the run-time application of rules and modifiers (i.e. bonuses and penalties) on player activities. As such, game successes and failures are in part a function of the character stats. Central to the RPG approach, the user will have a major role in determining his character's destiny and advancing that character's stats through continuing activities. Building the character becomes a central motivator for continuing game play. Note that stats are applied generically across all characters in the game, including both user-controlled characters and non-player characters (NPCs). In the case of NPCs, character stats will similarly impact the capabilities and competency of the artificial intelligence ("bots") used to control that character.

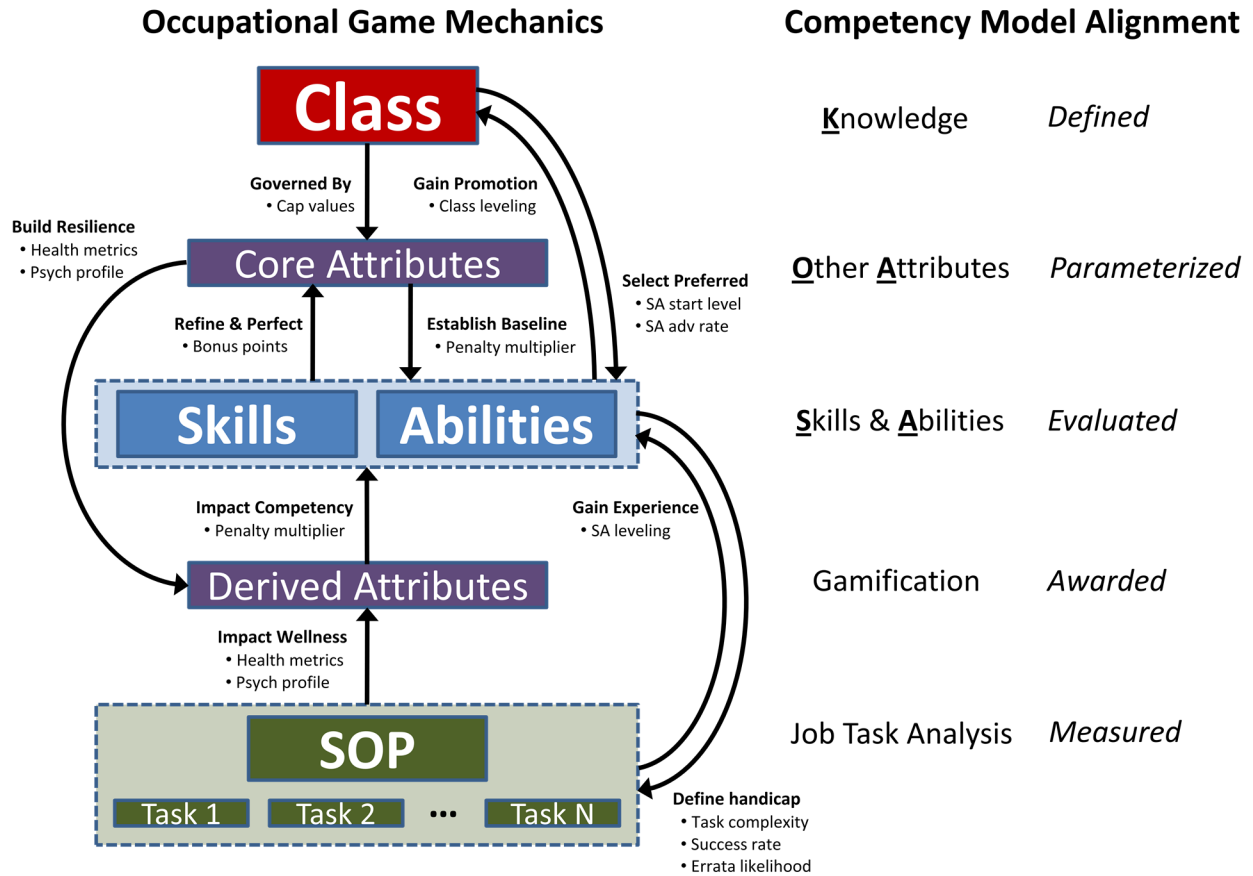


Figure 1. Overview of Occupational Game Mechanics.

Hazardous Day develops a new capacity to support competency-based evaluation and improved health exposure training through synthetic learning environments. Using a Role Playing Game (RPG) motif, the game will incorporate a five-tier approach to occupational safety which aligns to Knowledge, Skills, Abilities, and Other Attributes (KSAOs) defined in our Professional Competency Model for Mine Safety (Figure 1). In this design, a learner's *Class* designates his or her pre-existing knowledgebase in a particular job or profession, such as driver, mechanic, or electrician. *Core Attributes* provide a measure of intrinsic behavioral tendencies and talents for the individual, which can be derived from existing personality assays such as Predictive Index. *Skills and Abilities* define the components which are subsequently measured through the learner's performance of *Standard Operating Procedures (SOPs)* during game tasks; example SOPs will be included for workplace examinations, ore processing, and materials transport. The performance of SOPs can be measured quantitatively through game logging. The learner's choices and behaviors subsequently impact the *Derived Attributes* of his or her game avatar, providing feedback and enhancing engagement through positive or negative consequences in the game environment.

2.1.1 Biographical

- **Name**
User will select a fictional name (first & last). Character will be referenced by name throughout game. Real names may be used optionally at user/company discretion.
- **Biography**
User will provide a biography for the character. The biography will be displayed for all other users to see in multiplayer games. The pre-defined avatars will have their back stories reflected in the biography which should align to other character traits. The biography field may be left blank on custom characters.
- **Portrait**
A portrait will be generated for the character. The portrait is a snapshot of the head of the 3D avatar. Optionally a real photo may be provided by the user instead.

2.1.2 Professional

- **Production Quota**
Cumulative ore mined or processed for the site over the given shift. Users are required to meet site quotas and receive bonuses or fines from management depending on the shift quota. The production quota will serve as a principal antagonist and stressor for the game.
- **Player Earnings**
Player earnings replace scoring. Earnings are specified in credits akin to Dollars and Cents (may be described in other currencies also) and awarded based on successful completion of game objectives, such as tonnage mined or ore processed. There are multiple ways that players can be awarded credits depending on the job role. The award mechanisms are a function of class; for instance, a mechanic will be awarded differently than a truck driver. Earnings can be used by the player to make in-game purchases through a virtual Company Store that offers new equipment, upgrades, uniforms, and other 'swag' to be determined. Unlike traditional RPGs, users may also be *fined* for SOP errors, hazards, and safety citations. A detailed discussion of the virtual Monetary System of *Hazardous Day* may be found in Section 2, World Mechanics.

Disclaimer: In-game Player Earnings credits are non-negotiable and have no bearing on or correlation to any actual currency or client's salary and pay policies. This should be clarified via a disclaimer in the EULA. Furthermore, players should never be provided a method for purchasing in-game earnings credits. This should never become part of our business model.

- **Incident-free Hours**

Hours of game time with no incidents recorded against the player. Incident-free hours provide a bonus to player earnings according to the following table:

Table 1. Levels 1-10.

Incident-free Hours	<1.0	1.0	2.0	4.0	8.0	16.0+
Earnings Bonus Multiplier	1.0	1.10	1.20	1.30	1.40	1.50

2.1.3 Occupational

- **Class**

A character Class designates that character's primary occupational expertise. As on a job site, the user's occupational Class impacts the character's proficiency at performing certain tasks. Tasks are impacted based on the character's Class Bonuses and Skills.

Each Occupational Class has two governing Core Attributes (see Table 10). The Occupational Class therefore designates which Core Attributes a character should be good at -- and where a user should allocate more points during Character Creation (See Character Creation under Core Attributes in Section 2.1.4 below). Furthermore, the Occupational Class establishes the preferred Skills and Abilities that a character will require to complete job tasks (Table 6). There are three classes of Skills and Abilities: Major, Minor, and Miscellaneous. Preferred Skills and Abilities will start at higher proficiency levels and receive advancement bonuses for that Occupational Class over Skills and Abilities designated as Miscellaneous (non-occupational). The Core Attributes, Skills, and Abilities are discussed at length in the following sections.

Class Type. Motivated by the key job types for the mining industry, *Hazardous Day* models the following 12 Occupational Classes:

- **Driver**

Drivers specialize in the operation of powered haulage, including trucks and shuttle cars of all sizes. They are responsible for moving material within and from the mine to processing facilities and/or to rail lines.

- **Electrician**

Electrician install and repair electrical equipment and wiring. They are responsible for running checks on equipment and maintaining the health of all mine electrical systems.

- **Engineer**
Engineers design and plan mining systems and operations. Engineers are responsible for designing critical controls to conform with state and federal safety and environmental codes. Engineers have obtained the Professional Engineer (PE) license.

- **Foreman** (reserved)
Shift foremen are responsible for the safe and efficient operation of the mine site to meet production quotas. They oversee all activities of a crew during a work shift. Foremen conduct inspections, maintain records including time sheets and incident reports, and oversee all aspects of shift activities. Note that there is exactly one Foreman per shift. Additional Managers may work under the Foreman to supervise certain work areas or facilities.

Note: The Foreman is a powerful Class which is reserved for use exclusively by designated users or administrators.

- **Inspector** (reserved)
Inspectors are responsible for enforcing state and federal safety and environmental codes. They are responsible for periodic inspections of mines and hold various enforcement powers including citations and work stoppage. Inspectors are licensed and employed by MSHA or a state regulatory agency.

Note: The Inspector is a powerful Class which is reserved for use exclusively by designated users or administrators.

- **Laborer**
Laborers provide numerous services on the mine site, including moving materials, cleaning up areas, stocking warehouses, and assisting other employees with tasks under supervision. Laborers are considered to be a "Jacks of All Trades"; they do a variety of physical activities and frequently use handheld tools or light machinery in the performance of these tasks.

- **Manager**
Managers are responsible for the safe and efficient operation of certain mine facilities or operational areas. Managers supervise workers and equipment within their specific areas of expertise. They conduct inspections, maintain paperwork, and participate in the production activities relevant to their area of the worksite. Note that a worksite may have numerous managers, each responsible for a specific area or facility.

- **Machinist**
Machinists work on mine machinery and systems, including fabrication, assembly, and installation. They have high a mechanical proficiency with substantial expertise in both

milling and welding. Machinists often work with Mechanics to maintain or repair machinery.

- **Mechanic**

Mechanics maintain and repair all machinery and equipment on the worksite. Mechanics play a critical and time sensitive role in both preventative and corrective maintenance.

- **Operator**

Operators run various the types of heavy machinery on the worksite. Operators are responsible for mobile machinery, including drills, loaders, and shovels, as well as stationary equipment, such as crushers, screens, and conveyors. As such, Operators are one of the most versatile Classes on the worksite, as they participate in nearly every stage of minerals development, from extraction to processing to shipment.

- **Responder**

Responders deal with mine emergency situations of all sizes. They provide first response services when an emergency occurs, administering first aid and working to minimize loss of life and property. They are responsible for developing and overseeing mine emergency response plans and they organize and coordinate response efforts when an emergency occurs. Responders are also the 'boots on the ground' during mine rescue operations.

- **Trainer (reserved)**

Trainers are responsible for planning, training and maintaining workforce compliance with organizational, state, and federal health and safety training requirements. They are responsible for assessing worker competency and maintaining training records. Trainers yield a similar level of power as the Inspector Class. Trainers have obtained the MSHA Blue Card.

Note: The Trainer Class is a powerful class which is reserved for use exclusively by designated users or administrators.

Users of a Class A are *not* forbidden to do job activities outside their occupation; they are simply encumbered by not receiving the bonuses they would normally have by adhering to their class, and additional penalties may also be applied. Therefore the character may find those jobs more difficult to complete successfully or efficiently. As such, handicaps are naturally applied when the user attempts activities outside of their skill specialty. We may provision to allow users to change classes or multi-class at some point.

Class Leveling. In addition to a designation of prestige and advancement for the user, a character's Occupational Level has a direct bearing on its psychophysical Attributes, both

Core and Derived (Section 1.1.4). Specifically, at each Level, the Derived Attributes of Health, Fatigue, and Morale are increased as a linear function of Level and Core Attributes. Class level also has a modest impact on user rewards and penalties, as illustrated in Tables X and Y below. Furthermore, the user may selectively increment the Core Attributes with bonus points awarded during the Leveling-Up event. Core Attribute bonus points are discussed in Section 1.1.4 below. Note that unlike Skills and Attributes, character's Occupational Level itself can never be increased or reduced, either temporarily or permanently, outside of the Leveling-Up process discussed in this section.

Class Advancement. Users may increase their character's level by successfully advancing the preferred Skills and Abilities of the character's Occupational Class. Typically, a player character will start the game at Class level 1 and may advance to Class level 20. The cap is arbitrary and may be extended in the future, to the limit of Skills and Abilities advancement, for which Class level is a function. Note that we may also provide a facility to start an administrative user at a higher level than 1 for specific purposes (e.g. testing or scenario design). Correspondingly, we may provide a library of pre-built Player Characters (PCs) and Non-player Characters (NPCS) with greater starting levels to meet the needs of specific scenario design. Advancing the Class level, i.e. "Leveling-Up," requires that the user meet certain leveling thresholds in preferred (Major) Skills and Abilities, as well as minimum reputation score, as outlined in Table 2 and Table 3. As such, attaining a higher Class level will get progressively more difficult as the user advances the character.

The Leveling-Up of a character's Occupational Class is considered to be a significant (and rare) in-game event. Therefore it should be well represented with visual feedback and flair. The user should receive an award screen indicating the Leveling-Up achievement, followed by a stats screen showing how the character has improved and providing the user an opportunity to assign bonus points to Core Attributes.

Table 2. Levels 1-10.

	1	2	3	4	5	6	7	8	9	10
Required Major S&A Levels-Up (Cumulative)	0	5	10	20	30	40	60	80	100	120
Required Min Reputation (Cumulative)	0	5	10	15	20	25	30	35	40	45
Earnings Bonus Multiplier	1.0	1.05	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45
Errata Inject Likelihood (%)	25	24	23	22	21	20	19	18	17	16

Table 3. Levels 11-20.

	11	12	13	14	15	16	17	18	19	20
Required Major S&A Levels-Up (Cumulative)	150	180	210	240	270	300	350	400	450	500
Required Min Reputation (Cumulative)	50	55	60	65	70	75	80	85	90	95
Earnings Bonus Multiplier	1.50	1.55	1.60	1.65	1.70	1.75	1.80	1.85	1.90	1.95
Errata Inject Likelihood (%)	15	14	13	12	11	10	9	8	7	6

- **Skills**

In *Hazardous Day*, game Skills represent fundamental job skills as per KSAOs needed to execute tasks. Each task will have a governing Skill, and a character's Skill level directly impacts its proficiency and success rate in that task. A summary of game skill types is provided below.

Skill Type. The following 22 Skills are available:

- **Accounting**
Maintenance of any and all site records, including incident reports, environmental assessments, training compliance, production quotas, and company finances.
- **Blasting**
Preparation and use of explosives to separate or move materials, including the safe handling of detonators and other components.
- **Conveyance**
Operation of belt and pulley conveyor systems and associated machinery, including head drive, tail, and collectors, to move materials on the worksite.
- **Controls**
Design, execution, and up-keep of site critical controls at all levels of the controls hierarchy as necessary to maintain life and property.
- **Crushing**
Operation of equipment and facilities that crush or grind rock, so to maintain equipment integrity as well as desired throughput and consistency of materials.

- **Drilling**
Boring of holes in rock to collect core samples or prepare for blasting, including proper use of drill equipment and planning of drill hole locations and depth.
- **Dumping**
Emptying of materials into designated collectors, such as crushers, screens, or bins, without damage or spillage.
- **Electrical**
Installation, maintenance, and repair of electrical equipment, wiring, harnesses, panels, and other current-conducting elements.
- **First Aid**
Proper administering of first aid to treat injuries and save life when an incident occurs on the worksite.
- **Haulage**
Safe driving and control of any and all powered haulage to transport materials on, to, or from the work site.
- **Housekeeping**
Maintenance of safe and orderly work areas and travel surfaces which are free of extraneous equipment or refuse, in accordance with company and regulatory standards.
- **Inspection**
Examining an area to identify adverse conditions which affect health and safety and implementing corrective actions to resolve any such issues found.
- **Loading**
The loading of materials into designated haulage or conveyance without damage or spillage.
- **Maintenance**
Routine servicing and repair of equipment, machinery, and structures to maintain safe and efficient operation. Maintenance may be preventative or corrective.
- **Milling**
Cutting and shaping metal parts for use in servicing equipment or structures.
- **Pipefitting**
Installing, assembling, or fabricating pipe systems and infrastructure to handle wet or gaseous substances.

- **Rescue**
Responding to mine emergencies, including organizational planning, site preparations, and time-critical execution of emergency response plans.
- **Reagent**
The mixing of chemicals to purify or process ore in bulk and sample quantities.
- **Sampling**
Collection and interpretation of material samples, including rock, soil, and water.
- **Screening**
The mechanical separation of materials into various grades or levels of granularity, as well as routine maintenance of screening machinery to prevent binding.
- **Surveying**
The precise measurement of the worksite to identify positions, distances, and angles, in order to create maps or support mining design activities.
- **Welding**
The bonding metals together using chemical or electrical processes to create or repair structures and equipment.

Skill Level. Each Skill will be rated on a 0 to 100 level scale and divided into five skill classes, which include Novice, Apprentice, Journeyman, Expert, and Master. The skill classes influence the success rate of a task and the fidelity of control necessary to complete a task. Note that the skill level is capped at 100 and cannot go below 0 even with penalties or handicaps. For any skill, a Novice rating will incur a considerable success rate handicap. In most cases, users start at a skill level of Apprentice in the preferred skills for their class. The highest skill level is designated as Master level, which receives a considerable bonus. The Master level is designed to be difficult to obtain and thus requires a perfect skill level of 100. By design, most users will never obtain the Master skill level.

A Skill's starting level is dependent upon the preferred Skills and Abilities of the character's Occupational Class. In particular, Major Skills start at level 30 (intermediate Apprentice), Minor Skills start at level 20 (beginning Apprentice), and Miscellaneous Skills start at level 5 (inexperienced Novice). This design is meant to parallel real life training and assumed knowledge; instance, we would expect a Driver to have received considerable task training and certification to drive a haul truck (e.g. a Class Major Skill) but to have little if any experience in operating a crusher facility (e.g. a Class non-preferred Skill). This design both handicaps users in tasks for which they are not skilled, yet it does not artificially restrict users from doing (or attempting) those tasks outside of their job expertise.

Skill Advancement. Skills may be advanced based on the user's experience in successfully completing related tasks. Specifically, each task will allow the user to earn Skills & Abilities points (SA) toward the advancement of a related Skill. Points are awarded upon the successful completion of that task. Once the user reaches the threshold for Skill advancement, the Skill level is incremented and the user receives a visual notification of the "Leveling Up" event as a reward.

Each Skill level is equivalent to a set number of SA points as per Table 4. For instance, assuming a user starts a Skill at level 0, Skill level 1 will be achieved upon reaching a threshold of 150 SA points, whereas Skill level 25 will be reached at a threshold of 3,500 SA points (i.e. 20 Novice + 5 Apprentice levels, 20x150 + 5x100), and assuming no increase or reduction buffing occurs. Furthermore, an Occupational Class's Major skills are advanced at a rate bonus of 2.0X versus Minor and Miscellaneous skills. Note that Skills advancement shall be *relative* to the current *active* level of that Skill and achieved at 100-point intervals (150 for Novices) relative to the active level. As players will rarely start with a Skill of level 0, an offset must be applied based on the starting level. For instance, a user with a Skill starting at the Apprentice level (e.g. level 20, as per Table 4 above), level 21 would be awarded at 100 points and level 30 at 1000 points.

Skills may also be *increased* or *reduced*, either temporarily or permanently through Buffing (see Section X on Buffing). When Skills are increased or reduced, SA points are not added to or lost from the user's total on that Skill, but set aside in the calculation of the Skill's current level. The SA points awarded since the last Skill leveling-up are thus applied to advance from the current level to the next relative level. For instance, consider a temporary reduction in the current Skill level from C to C'. An intervening level-up event will raise the Skill level from C' to C'+1. The Skill level will be subsequently restored from C'+1 to C+1 when the reduction buff wears off. In the case of a permanent increase or reduction, all current and future leveling is based on the current, permanently increased or reduced level.

Table 4. Skill Mastery Levels.

	Novice	Apprentice	Journeyman	Expert	Master
SA Level Range	0-19	20-39	40-79	80-99	100
SA Points to Next Level	150	100	100	100	NA
Task Success Rate Bonus	-20	0	+10	+20	+30
Task Complexity Level	5	4	3	2	1
Errata Inject Likelihood (%)	100	75	50	25	1

Table 5. Bonuses for Class Preferred Skills.

	Major Skill	Minor Skill	Misc. Skill
Starting Level	30 (Apprentice)	20 (Apprentice)	5 (Novice)
SA Advancement Rate Multiplier	2.0	1.0	1.0

- **Abilities**

Abilities define soft skills. Ability level has an indirect impact on the proficiency of related job tasks. Note that abilities use the same bonus and advancement mechanics as Skills, defined in the previous section.

There are 7 Abilities, as follows:

- **Leadership**

The effective management of people toward a desired goal. Leadership incorporates a spectrum of talents that include supervising workers, making prudent decisions, dealing with conflicts and adversity, and facilitating efficient work.

- **Teamwork**

The ability to work effectively with other people to solve problems under a variety of circumstances. Teamwork is a key ability for most cooperative activities.

- **Communication**

Efficiently interacting with others to convey information and articulate thoughts. Good communication requires writing and speaking clearly, as well as listening attentively and properly interpreting the words of others.

- **Problem solving**

The ability to identify and understand problems, analyze evidence, and find solutions; strongly driven by critical thinking and motivated by the scientific method.

- **Work ethic**

Note: Out of an abundance of caution not to appear biased toward any occupation or ethnic group, we will not model Work Ethic in this game.

- **Flexibility**

The ease at which one adapts to new situations and adverse circumstances, including both openness to change and natural aptitude for tackling new challenges.

- **Interpersonal**

Maintaining a positive chemistry in relationships with others through high emotional intelligence and empathy. Includes the ability to correctly gauge the demeanor and intentions of others.

Table 6. Preferred Skills & Abilities by Class.

Class	Major	Minor
Driver	Dumping, Haulage, Inspection; Communication	Controls, Loading; Teamwork, Interpersonal
Electrician	Controls, Electrical, Inspection; Problem solving	Crushing, Housekeeping, Surveying; Communication
Engineer	Blasting, Controls, Surveying; Problem solving	Sampling, Reagent; Communication, Flexibility
Foreman	Controls, Inspection; Leadership, Problem Solving	Accounting; Communication, Flexibility, Interpersonal
Inspector	Controls, Inspection, Housekeeping; Flexibility	Accounting, Response; Communication, Interpersonal
Laborer	Housekeeping, Milling, Pipefitting; Flexibility	Conveyance, Screening; Communication, Interpersonal
Manager	Accounting; Communication, Leadership, Problem Solving	Controls, Inspection; Interpersonal, Teamwork
Machinist	Milling, Pipefitting, Welding; Problem solving	Housekeeping, Inspection, Maintenance; Communication
Mechanic	Maintenance; Communication Flexibility, Problem Solving	Inspection, Housekeeping, Milling, Welding
Operator	Crushing, Drilling, Loading, Screening	Conveyance, Dumping, Inspection; Communication
Responder	First Aid, Rescue; Communication, Teamwork	Controls; Flexibility, Interpersonal, Problem Solving
Trainer	First Aid, Housekeeping, Inspection; Interpersonal	Communication, Flexibility, Teamwork, Problem solving

Note: Blue indicates Skill; Red indicates Ability

2.1.4 Attributes

Attributes define the psychophysical attributes of both player characters (PCs) and non-player characters (NPCs). There are three types of Attributes: Physical, Core, and Derived. The influence of these Attribute types proceeds from Physical to Core to Derived. In particular, a character's Physical body structure influences its Core Attributes, which in turn impact the character's Derived attributes as well as its Skills and Abilities development. A detailed discussion on this chain of influence is given in the sections below.

- **Physical**

A character has three major Physical Attributes, as follows:

- **Height**

Character's height. Should convert Metric to American custom units. Users can select a height from the range 4'10 - 6'10 inclusive. Bounds should be provided to prevent absurd values. Values should affect avatar height in game.

- **Weight**

Character's weight. Should convert to Metric to American custom units. Users can select a weight from the range of 90 - 400 lbs, inclusive. Bounds should be provided to prevent absurd values. Height and weight determine Body Mass Index (BMI) according to the following formula:

$$\text{BMI} = \text{weight} / \text{height}^2 \quad \text{where weight} = \text{kg and height} = \text{m}$$

BMI impacts the Derived Attributes Maximum Fatigue and Fatigue Recovery (discussed below), as well as the visual build of avatar. The BMI modifiers are given in Table 7. Note that each modifier can be interpreted as a percentage reduction in the relevant attribute when computed as $(1 - \text{BMI}_{\text{Modifier}}) \times 100$.

Table 7. Modifiers for Body Mass Index.

	BMI Ratio (kg/m ²)	Maximum Fatigue (BMI _{FP})	Fatigue Recovery (BMI _{FR})
Underweight	<18.5	0.90	0.90
Normal	18.5-24.9	1.00	1.00
Overweight	25-29.9	0.90	0.90
Obese	>29.9	0.85	0.75

- **Fitness**

Character's muscle mass. Users can select the character's build from a range of physiques. Muscle mass, defined here as Fitness, impacts Maximum Health and Health Recovery, as well as visual build of the avatar. The Fitness modifiers are given in Table 8. Note that each modifier can be interpreted as a percentage reduction in the relevant attribute when computed as $(1 - \text{FIT}_{\text{Modifier}}) \times 100$.

Table 8. Modifiers for Fitness.

	Muscle Mass Delta (%)	Maximum Health (FIT _{HP})	Health Recovery (FIT _{HR})
Very Low	-10	0.90	0.90
Low	-5	0.95	0.95
Average	0	1.00	1.00
High	+5	1.05	1.05
Very High	+10	1.10	1.10

- **Core**

The Core Attributes define a character's fundamental psychophysical parameters. The Core Attributes are therefore central to the character's destiny and impact every aspect of that character's development, and consequently the user's game play with that character. Core Attributes are rated on a scale of 1 to 25, inclusive, with 25 being the maximum, i.e. "perfect," score for a Core Attribute. Note that only a Class' governing Core Attributes, as discussed below, may be advanced beyond 20.

The Core Attributes consider a character's natural talents, impacting the proficiency with which that character performs tasks governed by related Skills and Abilities. In particular, the success of any task is in part a function of the Core Attribute governing the Skill or Ability for that task. A ratio of the character's current Core Attribute level to the maximum attainable level for is used to compute a penalty multiplier for each Skill or Ability as follows:

$$\text{Penalty} = \min (\text{attrib}/25, 1) \text{ where } \text{attrib} > 0$$

The computation of task complexity, interaction, and success guidelines are discussed further in Section 2.2, World Mechanics.

The Core Attributes also impact the starting values and advancement of Derived Attributes, which include Health, Fatigue, Morale, and Reputation. The relationship between Core and Derived Attributes is discussed in detail below.

A character has 9 Core Attributes, as follows:

- **Attention (ATT)**

Attention to detail. Attention considers the character's attentiveness to following instructions and ability to execute the stage of a procedure with a high degree of precision.

- **Charisma (CHA)**
Likability and persuasiveness. Charisma considers how well a character gets along with others and how persuasive that character can be in making a point or steering a group toward a common goal.
- **Dexterity (DEX)**
Physical coordination. Dexterity measures a character's hand and eye coordination, impacting the ability to execute complex motions with instruments or tools and to precisely control heavy machinery.
- **Endurance (END)**
Resilience to exertion. Measures a character's ability to sustain physical and mental activity for a period of time. Endurance also impacts the character's ability to recover from fatigue or exposure and to resist injury.
- **Intelligence (INT)**
Mental capacity. A measure of fluid intelligence, this attribute governs the character's ability to solve complex problems. It defines the ease with which the character can identify solutions and perform complicated cognitive tasks.
- **Patience (PAT)**
Emotional composure. Describes the ability to tolerate setbacks and stay the course through tedious or difficult activities. Patience also impacts a character's ability to interact productively with conflicting personality types.
- **Strength (STR)**
Muscle strength. Provides a measure of the physical strength that a character can apply to move heavy objects, carry heavy items, and manipulate bulky machinery.
- **Speed (SPD)**
Rate of movement. Defines how quickly a character can perform a series of body motions, impacting the rate of task completion. Speed also affects recovery rate for fatigue and injury.
- **Luck (LCK)**
Good fortune. The possibility of a positive outcome being attained not through intentional actions but by chance and circumstance. A character's Luck has a small net impact on everything he or she does.

Each Core Attribute governs three to four Skills and Abilities. The governing attributes for each Skill and Ability are shown in Table 9. Note that Luck governs no specific Skills or Abilities, but it has a modest impact on tasks across all Skills and Abilities.

Table 9. Governing Attributes for Skills and Abilities.

Attribute	Skills	Abilities
Attention (ATT)	Accounting, Blasting, Inspection	Communication
Charisma (CHA)	First Aid	Leadership, Interpersonal
Dexterity (DEX)	Crushing, Dumping, Maintenance, Welding	
Endurance (END)	Drilling, Haulage	Flexibility
Intelligence (INT)	Controls, Electrical, Reagent	Problem Solving
Patience (PAT)	Housekeeping, Sampling, Surveying	Teamwork
Strength (STR)	Loading, Milling, Pipefitting	
Speed (SPD)	Conveyance, Response, Screening	
Luck (LCK)	Modest impact on all	Modest impact on all

Furthermore, each Occupational Class is governed by two Core Attributes, as illustrated by the shaded cells in Table 10, and every attribute governs at least two (and up to four) Classes, with the exception of Luck (LCK). As discussed, the Class' governing Core Attributes are allowed to reach a higher cap value (25) than the non-governing attributes of that Class. Note that the governing attributes of each Class must correlate with the Major Skills and Abilities of that Class in order to provide for well-balanced Class advancement. Also, the game has been designed such that no two classes have the same set of governing attributes, so that each class requires unique gameplay strategies which align with relevant real world activities for that Occupational Class.

Table 10. Governing Attributes for Occupational Class.

Class	Governing Attributes (Darkened Cells)								
	ATT	CHA	DEX	END	INT	PAT	STR	SPD	LCK
Driver	XX		X	X					
Electrician	X				XXX				
Engineer	X				XX	X			
Foreman	X	X			XX				
Inspector	X			X	X	X			
Laborer				X		X	XX		
Manager	XX	X			X				
Machinist			X		X		XX		
Mechanic	X		X	X	X				
Operator			X	X			X	X	
Rescuer	X	X				X		X	
Trainer	X	XX				X			

Note: **Blue** indicates Major Skill for Class; **Red** indicates Major Ability for Class

Character Creation. The Core Attributes have maximum attainable values (caps). For a Class's governing attributes (Table 10 above), the cap is 25, whereas it is 20 for all non-governing attributes. Note that Core Attributes cannot be increased (buffed) beyond these maximums. During character creation, the Attribute scores are determined as follows:

1. Determine the starting value for each Core Attribute using a dice roll. Random values shall be mapped to the range [4..16].

A "re-roll" feature will allow the baseline Attributes to be re-computed as a group, up to *N* times, if the user is unhappy with the current configuration.

2. Apply Bonuses according to the character's Physical Attributes, as defined above.
3. Allocate 6 bonus points to the starting values of the Core Attributes. The 6 points are distributed arbitrarily among the Attributes at the user's discretion. Note that a Core Attribute *cannot* be adjusted to a starting value above 20, even if the cap is 25.

Attribute Advancement. A user is allowed to increase Core Attributes every 4th level, i.e. at levels 4, 8, 12, 16, and 20. At these designated levels, the user is given 2 points to allocate at will to the Core Attributes he or she selects. Two Attributes may be increased by 1 point, or 1 attribute may be increased by 2 points. No Attribute may be increased beyond the Attribute's cap value -- which is 25 for the Class' governing attributes and 20 for its non-governing attributes. These increases have an impact on all subsequent calculations, including future increases in Derived Attributes (see below), as well as task success related to the Skills and Abilities governed by the Core Attribute. Note that the increases in Core Attributes are not applied retro-actively to prior calculations.

- **Derived**

Hazardous Day employs four Derived Attributes: Health, Fatigue, Morale, and Reputation. The Derived Attributes impact game play in a variety of ways. They directly establish health and wellness (e.g. when a player loses consciousness or dies) and impact the success rate Skills and Abilities governed by specific Core Attributes. Note that each Skill and Ability is affected by exactly two Derived Attributes according to its governing Core Attributes as determined in Table 11. For instance, a low Fatigue impacts Skills and Abilities governed by the Core Attributes of Attention (ATT) and Endurance (END), among others. Similarly, Morale impacts tasks requiring Skills or Abilities governed by Charisma (CHA) and Patience (PAT).

The Derived Attributes are computed at character creation time as a function of the Core Attributes. Likewise the Derived Attributes are enhanced during Level-up based on a linear function of governing Core Attributes. The creation and level-up functions are defined below.

Table 11. Correlation Between Core and Derived Attributes.

Derived	Core								
	ATT	CHA	DEX	END	INT	PAT	STR	SPD	LCK
Health			X	X			X	X	
Fatigue	X		X	X	X		X	X	
Morale	X	X			X	X			
Reputation		X			X	X			

Note: Shaded cells indicate attributes used in leveling-up formulae.

A character has 4 Derived Attributes with the following effects:

○ **Health**

Health defines a character's hit points. Characters become more physically ill or injured, and consequently less able to perform tasks, as their health declines. Health incurs a penalty multiplier on tasks requiring Skills and Abilities governed by Dexterity (DEX), Endurance (END), Strength (STR), and Speed (SPD), in proportion to the ratio of $Health_{Current} / Health_{Max}$.

The starting maximum Health for Level 1 is determined as a function of the Core Attributes according to the following formula:

$$Health_{Max,1} = 2.0 (END+STR) * FIT_{HP}$$

Accordingly, Maximum Health increases by 10% of its related Core Attributes with each level-up event, from Level N to Level N+1, according to the following formula:

$$Health_{Max,N+1} = \text{ceil}(0.1 (END+STR) * FIT_{HP}) + Health_{Max,N}$$

With this formulation, increasing the relevant Core Attributes will directly impact the growth of Health resiliency with each subsequent level-up.

Health is reduced by injurious activities and exposure. Note that Health points are not autonomously restored during the course of a game. Health points may only be restored via specific healing activities or items. Users will have limited options to heal injured characters in game. When Health reaches 0, the character dies. Death is a significant game event which may be persistent; administrator intervention may be required to 'resurrect' a character if authorized. The impacts of game activities on character health, as well as the healing of injuries and persistent death, are outlined in Section 2.2 (World Mechanics).

○ **Fatigue**

Fatigue defines a character's current fatigue resiliency. Characters become more physically and mentally sluggish, and consequently less able to perform tasks, as they become more fatigued. Fatigue incurs a penalty multiplier on tasks requiring Skills and Abilities governed by the Core Attributes of Attention (ATT), Dexterity (DEX), Endurance (END), Intelligence (FAT), Strength (STR), and Speed (SPD), in proportion to the ratio of

$\text{Fatigue}_{\text{Current}} / \text{Fatigue}_{\text{Max}}$. Note that Fatigue is related to more Core Attributes than any other Derived Attribute.

The starting maximum Fatigue for Level 1 is determined as a function of the Core Attributes according to the following formula:

$$\text{Fatigue}_{\text{Max},1} = (\text{ATT}+\text{DEX}+\text{END}+\text{INT}+\text{STR}+\text{SPD}) * \text{BMI}_{\text{FP}}$$

Accordingly, Maximum Fatigue increases by 10% of its related Core Attributes with each level-up event, from Level N to Level N+1, according to the following formula:

$$\text{Fatigue}_{\text{Max},N+1} = \text{ceil}(0.1(\text{END}+\text{SPD}) * \text{BMI}_{\text{FP}}) + \text{Fatigue}_{\text{Max},N}$$

With this formulation, increasing the relevant Core Attributes will directly impact the growth of Fatigue resilience with each subsequent level-up.

Fatigue is continually lowered by exertion-based activities as discussed in Section 2.2 (World Mechanics). When Fatigue reaches 0, the character becomes temporarily unconscious. A character remains unconscious, and thus immobile, for a penalty period equal to 25 seconds minus Level, before Fatigue points start to recover.

Fatigue points are restored only very slowly over the course of a game. The restoration of Fatigue points competes against and offsets any exertion-based activity. Fatigue points are optimally restored for characters at rest. Furthermore, characters with a high Endurance may gain Fatigue points even while performing low exertion activities. Fatigue points are restored according to the following mechanic:

$$\text{Fatigue}_{\text{Current},s+1} = C_{\text{Fat}} * \text{LVL} * \text{DIF} * \text{END} * \text{BMI}_{\text{FR}} + \text{Fatigue}_{\text{Current},s}$$

where s is the time step, assumed here to be 1.0 second, C_{Fat} is the Fatigue restoration rate coefficient, assumed to be 0.005, and LVL is the character's current level. This rate was benchmarked by assuming that a Level 1 character with perfect Endurance (i.e. 20) and perfect Fatigue resiliency (120, i.e. all relevant Core Attributes at 20) would be fully rested in 20 minutes. Note that, as Level and Endurance increase, so does the rate of Fatigue restoration. Fatigue restoration may also be throttled by a difficulty coefficient (DIF).

- **Morale**

Morale defines a character's current mental resiliency. Characters become more irritable and have a harder time performing tasks correctly as morale decreases. Morale incurs a penalty multiplier on tasks requiring Skills and Abilities governed by Attention (ATT), Charisma (CHA), Intelligence (FAT), and Patience (PAT), in proportion to the ratio of $\text{Morale}_{\text{Current}} / \text{Morale}_{\text{Max}}$.

The starting maximum Morale for Level 1 is determined as a function of the Core Attributes according to the following formula:

$$\text{Morale}_{\text{Max},1} = \text{ATT}+\text{CHA}+\text{INT}+\text{PAT}$$

Accordingly, Maximum Morale increases by 10% of its related Core Attributes with each level-up event, from Level N to Level $N+1$, according to the following formula:

$$\text{Morale}_{\text{Max},N+1} = \text{ceil}(0.1(\text{CHA}+\text{PAT})) + \text{Morale}_{\text{Max},N}$$

With this formulation, increasing the relevant Core Attributes will directly impact the growth of mental resilience with each subsequent level-up.

Morale is lowered by poor consequences and interactions with conflicting personalities, as discussed in Section 2.2 (World Mechanics). When Morale reaches 0, the character has a mental breakdown and becomes combative, unwilling to participate in any activities. A character remains in the breakdown state, and thus uncooperative, for a penalty period equal to 25 seconds minus Level, before Morale points start to recover.

Morale points increase through positive consequences and feedback, as discussed in Section 2.2 (World Mechanics). Furthermore, morale is restored automatically but at a very slow rate, until the character's Morale reaches 50% of maximum. Morale points are restored automatically as follows:

$$\text{Morale}_{\text{Current},S+1} = C_{\text{Mr1}} * \text{LVL} * \text{DIF} * \text{CHA} + \text{Morale}_{\text{Current},S}$$

where S is the time step, assumed here to be 1.0 second, C_{Mr1} is the Morale restoration rate coefficient, assumed to be 0.0017, and LVL is the character's current level. This rate was benchmarked by assuming that a Level 1 character with perfect Charisma (i.e. 20) and perfect Morale resiliency (80, i.e. all relevant Core Attributes at 20) would be restored to 50% Morale in 20 minutes. Note that, as Level and Charisma increase, so does the rate of Morale restoration. Morale restoration may also be throttled by a difficulty coefficient (DIF).

- **Reputation**

Similar to the Lore mechanic used in some RPG games, Reputation measures a character's history of achievements or misdeeds. Reputation plays a role in how a character is perceived by others in the game world. Reputation also impacts Level advancement, in that a minimum score is required to obtain each level (see Table X2 and Table 3). Reputation can also impact a character's ability to complete certain tasks. In particular, a penalty multiplier is applied to tasks requiring Skills and Abilities governed by Charisma (ATT), Intelligence (INT), and Patience (PAT), in proportion to the ratio of $\text{Reputation}_{\text{Current}} / \text{Reputation}_{\text{Max}}$.

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