OF TWO MINDS - One Human, One Not
Mental Health in the Era of Artificial Intelligence
JUNE, 2019

The world is crossing an historic bridge spanning human and artificial intelligence and the result is a meeting of two minds – one human, one not. Can we keep both healthy? That is unclear.

By Bill Wilkerson, LL. D. (Hon),
Executive Chairman, Mental Health International
and
Industry Professor, International Mental Health,
McMaster University, Hamilton, Ontario, Canada

Dedication: The Late Honorable Michael Wilson

"My partner in workplace mental health for 20 unbroken years.

Mike was to be the co-author of this analysis. Fate took a different turn.

So I commend 'OF TWO MINDS' to the reader in the spirit of this great man"

Bill Wilkerson, Port Hope, Ontario, Canada, 2019

PROJECT SPONSORS

PURPOSE OF THIS REPORT

This report aims to reach leaders in government, science and business with recommendations that AI must be managed carefully to prevent it from becoming a major intruder into the mental health and well being of working populations and families. We cite the spectre of Unintended Consequence as one principal threat and massive job loss, a predictable if not intended consequence of AI, as another.

Scientists, developers and users of AI must exercise vigilance and diligence needed to not make the global burden of mental illness heavier. And to bring these matters to the fore, this substance and recommendations of this report will be submitted to the Canadian Institute for Advanced Research, the Quebec International Observatory on the Societal Effects of Artificial Intelligence with a view to incorporating mental heath considerations in these important strategic initiatives.

We will also submit the report to the European Brain Council, US National Institute for Mental Health, Canadian Institute for Health Research, government ministers, individual leaders in business and science, certain public sector figures and the news media.

IN PRELUDE

"Together the revolutions in genomics and artificial intelligence are forcing us to re-visit long-held, cherished views of what it means to be human." – Dr. Alan Bernstein Chief Executive Officer, Canadian Institute for Advanced Research, Toronto, Ontario, in an interview for this report.

"Stress is the Holy Grail of science because it is essential to survival and yet can be severely damaging to the health and wellbeing of millions. It is very possible artificial intelligence will tilt the balance toward the negative among those individuals already vulnerable to, and symptomatic of mental illness." – Dr. Rémi Quirion, Chief Scientist of Québec.

INTRODUCTION and SUMMARY

Through MHI and its predecessor, Global Business and Economic Roundtable on Mental Health, the author has written a number of reports focusing on mental health issues germane to the work environment, stress and the co-morbidity of depression and various chronic disorders.

This Report is the author's first attempt to assess the mental health effects of AI at a time of imminent dissemination of AI into all quarters of life – culture, science, societal arrangements, jobs and the economy.

Based on analysis reports, studies and commentary by experts in the field, 'OF TWO MINDS' finds that AI represents a clear and present danger to the livelihood and health of hundreds of millions of working people and their families worldwide.

The revolution in AI threatens to displace and replace human beings in whole jobs and specific tasks on an unprecedented scale. Even the most informed proponents of AI worry about this.

The World Economic Forum forecasts that individuals in some 375 million jobs will be rotated out of those jobs. According to consulting giant McKinsey, 60-90% of all jobs now in place will be affected by AI.

Unless employers and governments prepare for this revolution by retraining workers, creating replacement jobs that demand distinctly human traits, and forging new education and career models, social unrest and alienation will intensify in a world already fractured by income inequality and a gaping 'have-have not' divide.

If AI blows like a blizzard or drops like a bomb on the workplace as the world makes the transition to a brain-based, digital economy, the most significant unintended consequence of this revolution will be to increase the burden of human distress, disquiet and clinical disorder across the world.

As the AI revolution takes hold, working populations must be prepared for the jolting adjustments triggered by AI. The Deep Learning of machines will generate Deep Stress for people who face the invasive uncertainty and disruption caused by AI technologies.

Super Power of Stress

The scale of the AI revolution demands a sophisticated, well-funded and techno-savvy re-training and skills development campaign by governments, businesses, AI technology designers and users.

AI will be a super-power of dangerous, deep stress with the capacity to produce rumination that, in turn, predicts depression. Deep stress is at the root of severe frustration, fear, anger and uncertainty. These can threaten one's sense of personal identity and self-awareness.

Self-awareness is not a bland psychological concept. It is, in fact, everything. It is our understanding of who we are and what we are here to do, it is the source of our congruence with the world around us.

Deep, chronic stress can move us toward self-destruction. Just as cancer is a malignant growth, depression – in the words of author Lewis Wolpen - is malignant darkness.

It is also the trigger of 90% of suicides, now the leading cause of violent death. Human beings are killing ourselves faster than we are killing other people. Guns kill more Americans through suicide than homicide.

In late 2018, according to the Economist, suicides in the United States skyrocketed 18% between 200-2017 while globally, suicide declined by nearly 29%, saving nearly three million lives.

Across the world, 50% of human beings are symptomatic of mental illness – 20% in any given year. And these human beings are the faces of the troubled, turbulent times in which the effects of AI will be felt.

AI 'New Technology' Is Different – Very Different

This is the first time that technology – through AI and genomics (synthetic biology) is moving toward the replication of human beings, man-created "new biological beings," a re-statement, in effect, of the human place in work and culture.

Dr. Bernstein sees "AI as such a powerful platform for analyzing data in new ways that its applications will extend into every aspect of our lives" -- energy, medicine, arts and culture.

The implications of this technology are different than past technologies. Its reach into society is penetrating. It has the potential to create an ambiguous and troubling 'middle ground' between machines and human beings. Yes, this new technology is different – very different.

One thing it means to be human in the era of AI is living with mental illness. This, at a time when the human mind now does the heavy lifting for business and is at risk of being costly collateral damage from the vast infusion of AI into the digital economy.

Indeed, the world is crossing an historic bridge between human and AI, bringing together two minds, one human, one not. Can we keep them both healthy? That is unclear. But this much isn't:

- If AI feeds human mental unrest, disquiet and disorder, then it will damage society; if AI is cloaked in confusion and lack of transparency, then it will emotionally pollute the environments in which people live and work.

- If the sole purpose of AI is to displace employees to cut costs, then it will not only cheapen the cost of producing goods and services, it will cheapen our way of life.

Have human beings been 'set up' by the pollution of social media - that we are inhaling like cigarettes - to simply absorb this invasion? Will we react too casually – as if AI was just another step along the way to a digitization of how we do things?

The Promising Side of Perilous Technology

On a promising note, just as AI may increase the burden of mental illness, AI apps are being developed to help us better manage depression and anxiety disorders – and even to prevent suicidal risk.

AI is being developed to diagnose and treat schizophrenia more effectively, model psychiatric illness to test new methods of treatment, improve the diagnosis of schizophrenia, improve understanding of autism.

The Government of Canada has invested heavily in AI systems for internal use, introducing a 'Directive on Automated Decision-Making' and an "algorithmic assessment" to spell out ethical responsibilities for the use of AI within the government itself.

Human Capitalization of the Digital Economy

This report on mental health in the era of AI calls for the **"human capitalization"** of the AI workplace and digital economy to help balance the billion-dollar investments in machines with billion-dollar investments in people to ensure the supremacy of human beings in the AI workplace.

Human capitalization means investments in people in the era of AI - re-training, skills re-development, guaranteed adjustment periods at full salary for those whose jobs are lost.

The Brookings Institute calls for the advancement of a constant-learning mindset, reskilling incumbent workers, fostering employment opportunities that demand uniquely human qualities, focus AI on taking over specific tasks not whole jobs.

The idea of future-proofing vulnerable regions is a lesson learned from globalization. Do we need to learn it twice as the AI revolution takes hold? "Almost no occupation will be unaffected by technological change in the AI era," Brookings says, "and some of the most vulnerable jobs will be in office administration, production, transportation and food preparation."

Human capitalization of the AI workplace should start now with the introduction of workplace protocols or standards - mandated by law, if necessary – to establish the values that will govern entry of AI into the workplace, assess the threats to those values and take steps necessary to neutralize those threats.

AI Also Major Human Event

The AI revolution is not just a technology event, it is a human event. Surely, it can be leveraged into a positive and transformative, 'new job' and 'new career' experience for the people who otherwise are written off as short-term pain.

The advent of AI can be perceived and deployed as a powerful new tool in efforts to prevent the disabling and deadly effects of mental illness and to that end, the author of this report recommends that AI technologies and computational sciences be assessed as to the role these disciplines can play in helping to define the possibilities and limits of creating a "Prevention Infrastructure" through:

- Innovative clinical care, societal reforms to contain the sources and effects of deep stress among human beings, vigilance in identifying and reducing childhood risk and targeted economic investments including what this report calls 'the Human Capitalization' of the AI workplace and digital economy.

- The 'Human Capitalization' process will balance investments in deep learning and smart machines with investments in preparing, equipping and empowering people in the face of AI-driven disruptive change.

Further, this Report recommends that *'mental health considerations'* be incorporated into the Pan-Canadian Strategy on Artificial Intelligence being led by the Canadian Institute for Advanced Research and the Québec International Observatory on the Societal Effects of Artificial Intelligence.

(We have received word that this recommendation will be accepted and mental health will be built-into these international AI strategies, a world first.)

Science and Society – 'A Brighter Future Conference'

McMaster University was recently acclaimed 2nd in the world among 500 universities in 80 countries for its commitment to the Sustainable Development Goals of the United Nations, specifically, health, wellbeing, decent work and economic growth. It is the right place and the right time for a 'Science and Society Conference on International Mental Health in the Era of Artificial Intelligence' to put these matters before leaders in science, business, education and government.

This, in search of a practical but bold social, scientific and economic initiative aimed squarely at securing a formula for the prevention of the disabling and deadly effects of mental illness in the face of vast technological change and uncertainty driven by artificial intelligence. *(It appears this conference will be held on October 23, 2019, at McMaster's splendid Hamilton campus.)*

The Report - Mental Health in the Era of Artificial Intelligence

PART ONE

Human and Artificial Intelligence: Can We Keep Them Both Healthy?

The world is crossing an historic bridge spanning human and AI and the result is a meeting *of two minds – one human, one not.* Can we keep both healthy? That is unclear.

The great scientist Alan Bernstein, President and CEO, Canadian Institute for Advanced Research, sees *"AI as such a powerful platform for analyzing data in new ways that its applications will extend into virtually every aspect of our lives and every area of research*."

"Together, the revolution in genomics and artificial intelligence," Dr. Bernstein says, *"are forcing us to re-visit long-held, cherished views of what it means to be human."*

The World Economic Forum offers a similar perspective: *"In a world where activities and decisions once undertaken exclusively by human beings will be replaced or augmented by AI, profound questions arise as to what it means to be human."*

One thing it means to be human is living with mental illness and, conversely, using AI to help stem the tide of the world mental health crisis. The conditions we label as mental illness occur across the mainstream of life. Every living person is vulnerable. No exceptions. Public awareness of mental health and mental illness has risen sharply. And we have long since passed that threshold as a marker of success in "normalizing" discussion of these subjects.

AI embodies both promise and peril (as is often declared by experts in the field). When it comes to mental health, AI promises new tools to fight mental illness but simultaneously, it houses man-made stress and emotional distress at a time when 50% of the world population is lifetime symptomatic of mental illness.

The effects of AI will be heavily centered on working populations and families already stressed-out by the globalization of industries, job losses and the pervasive, addictive attributes of social media, on-line misinformation and all-day/all-night bad news generated by cable television and various digital platforms.

In Pursuit of a Great Goal

The report is not a scientific document, it is a document about science, a journalistically-styled text and sources are quoted on the spot. Where the author makes "editorial comments," that will be self-evident.

This report connects a lot of dots and creates a universe of collated information and ideas that otherwise remain unlinked. Epigenetics and AI illustrate this point.

Based on emerging and "known" scientific knowledge, and a higher level of public awareness of mental health as a common and pressing public concern, the author suggests we now have the premise for science and society to pursue – plausibly, and comprehensively – a great, audacious goal:

The prevention of the disabling and deadly effects of mental illness in the 3rd decade of the 21st century. The incentives for setting and pursuing for such a goal:

- The world's transition to a <u>brain-based economy</u> that, by definition, provides economic incentives for investments in <u>brain-based mental health</u> while accentuating, also by definition, the disturbing effects of mental illness on <u>brain-based</u> <u>productive capacity</u> in workforces across the world.

- The dawning of a new era of discovery in the field of genetics, epigenetics and brain science that could lead the way to ending the crisis in world mental health if – IF! – strategic research investments in these allied fields are adequate, sustainable and transmit the results into "clinical care." A genuine concern.

- The effects of the stress epidemic. The environments that we, human beings, create, and are born into, and in which we live and work are instrumental in causing disease including mental illness. This, chronic disorders overtake infectious disease as #1 world public health concern.

Stress and the Loss of Self at work

AI may force 375 million people to switch and lose occupations. The kind of stress that invades the individual's sense of self, sense of place and sense of purpose at work and in life. AI is likely to be a source of the kinds of stress that the National Institute for Mental Health has identified as a "Negative Valence System" of risk factors that can drive mental illness: fear, frustration, rumination, threat, anxiety and loss.

These specific risk factors contest those cerebral skillsets demanded by brain-based economy – trust, fairness, job fulfillment, common sense and common decency. Once seen as the 'soft side' of managing the workplace, fostering these qualities of mind and spirit constitute the new Hard Skills of Management for the AI workplace.

Human vulnerability to AI will be triggered by how the deployment of AI takes place and whether it is a serious affront to *"who I am, my self-worth, my self-esteem, whether it generates emotional and physical isolation, rumination, deep frustration."* Whether, like mental illness, AI digs into the inner self with invasive doubts, uncertainty and fear: in the face of AI, what does it mean to be human – TO ME?

Deep Uncertainty

Nobel Laureate Dr. Eric Kandel tells us that "preserving or losing the self" is crucial to all human beings: "self-awareness leads us to why we exist - one's sense of purpose and sense of being present." In fact, this is what mental illness undoes. This is what AI could lead to through deep employment uncertainty and through the bloodless or careless infusion of AI into the work lives of hundreds of millions of people.

The loss of self, loss of purpose, a fading personal identity. In effect, the stuff of depression, anxiety and for some, the stuff of suicide. On this basis, we can see that AI – specifically its massive injection into our lives - contains a roster of "causes and effects" and these will play out according to the wisdom or foolishness with which AI is introduced in full measure.

For example:

- If AI is "injected" like a bulky drug into the mainline of society, the economy and the workplace without planning, transparency and training for those directly affected, if it happens like social media arrived in the late 1990s and 2000s - haphazard, a blizzard of one-off inventions and built-in obsolescence via products designed to attract addictive use by people - then human beings must be encouraged to protest this and protest it hard.

- If the apparent motive behind AI is discerned by employees to replace them, without creating new employment opportunities, then AI will be unwelcome and will profoundly worsen the "stress" experience of employees who work alongside these machines and are expected to see them as co-workers, thus losing their sense of place and sense of self.

- If AI deepens the effects of distraction, isolation, fear and uncertainty which feeds mental unrest and distress, then AI will damage society. If robots give the aging and aged compassion and companionship and relieve human beings of this "duty," machines will become human to the lonely and alone.

- If AI replaces health care workers to cut costs, it is misplaced. If AI is trained to produce racial bias or think violently, then its own "brain" will be troubled.

These statements are more cautionary than predictive. At the same time, even the spectre or apprehension of AI's impact on the lives of people can, over time, affect mental health and wellbeing. Therefore, the prospects, promise and peril of AI must be communicated and transparently planned for. Clarity of purposes and clear boundaries between the superiority of the human beings and the secondary, support role that technology plays must be clearly established.

Human Capitalization of the Digital Economy

Consulting giant KPMG, in its global analysis of mental health, concluded that "mental health development is economic development – important in a world built around human capital and knowledge."

In that light, the mental health of employees – the key source of productivity in a brain-based economy - becomes part of the asset value of effective organizations. So now is the time to seek incentives for employers to spend money on measures to support and re-train employees during a time of (projected) momentous change.

One tool proposed in this Report is a tax incentive through which (in Canada, as one jurisdiction) investments of this nature are tax-deductible at an enhanced rate, 1.25 times the actual amount spent. Alternatively, spending for these purposes could generate a tax credit.

There is precedent in Canada for this. Spending on salaries that qualify for research and development already generate an enhanced tax benefit over and above the actual spending on R&D equipment. In an economy where brain skills are needed to perform work relating directly to profitable and competitive operations, recognizing investments in those skills makes ample sense.

This measure could be part of an overall concept we call the "***Human Capitalization"*** of the brain-based, digital economy in the era of AI. In this way, in this new era, the workplace might become a test bed for the introduction of public mental health principles in the AI era - education and prevention – which are financed or at least incentivized by this new tax incentive.

Global AI Pioneer Speaks Out

Kai-Fu Lee believes that civilization will soon face an AI-induced crisis that will disrupt our economic and political systems and even cut to the core of what it means to be human in the 21st century. "In short, this is the coming of crisis of jobs and inequality", he says, adding, "our present AI capabilities can create a super intelligence that destroys our civilization. But my fear is that we humans may prove more than up to that task." Stephen Hawking said precisely the same thing in his last book.

Drawing on his best seller - "AI Superpowers: The New World Order," we learn that Mr. Lee is concerned that:

AI will exacerbate global economic inequality, put 3rd world shops stocked with armies of low wage workers out of business, cut away the bottom rungs on the ladder of economic development, deprive poor countries of the opportunity to kick-start economic growth through low-cost exports.

Even in rich and technologically advanced countries, AI will further cleave open the divide between the haves and the have-nots. The industry juggernauts of the AI age will see profits soar to previously unimaginable levels. This concentration of economic power in the hands of a few will rub salt in the wounds of social inequality.

Lurking beneath this social and economic turmoil will be psychological struggle, one that won't make the headlines but that could make all the difference. As more and more people see themselves displaced by machines, they will be forced to answer a far deeper question in an age of intelligent machines, what does it mean to be human?

A large contingent of economists and techno-optimists believe that fears about technology-induced job losses are fundamentally unfounded,' that the real story is technological change and economic development improves human productivity and lowers the price of goods and services, increases spending power and demands for labor and job.

An AI-Eye to the Future

Noting the escalating rise of AI, the World Economic Forum's 2018 Jobs Report looked at 20 economies and 12 industry sectors and advises business to be ready for:

1. High-speed mobile internet, AI, big data analytics, and robotic technologies that are set to "spearhead adoption of new technologies through 2022."
2. Job roles based on distinctively human traits growing – such as service, sales, marketing and culture, organizational management and innovation.
3. Decline in the number of "total task hours" done by humans slumping from 71% to 58% with 42% of these tasks performed by machines or algorithms by 2022.
4. Significant job dislocation, existing "job roles" becoming obsolete but a "net positive outlook" for jobs with "newly emerging occupations."

One report put it this way: "AI, it seems, has come of age, feasting on the vast data sets generated by our hyper-connected world from the outpourings of social media to warehouses of medical reports and meteorological data points, the machines are getting smarter at a dizzying rate."

The Royal Bank of Canada says more than 25% of Canadian jobs will be heavily disrupted by AI. The World Economic Forum has launched an initiative to help shape "the future of the Digital Economy and Society". One area of concentration is the "digital transformation of industries" and fostering values such as trust and resilience.

Accordingly, big data analysis, web and app markets, machine-learning and augmented and virtual reality are among the technologies that most companies will adopt by 2022. Humanoid robots, underwater robots and biotechnology are the least-likely to draw investment.

A report by researchers at Memorial University in St. John's, Newfoundland, projects that by 2025, there will be more than 50 billion devices connected to the Internet. This foretells disruption in a wide range of industries including offshore activities. Quoting the Memorial study, McKinsey has estimated that digitization of both technical and non-technical work may automate 60 to 90 per cent of routine manual tasks in traditional manual jobs.

4th Industrial Revolution

Another new report from the World Economic Forum – "The Future of Jobs" – says, "creativity will become one of the top three skills that workers will need by 2020". Creativity is a cognitive function, a brain skill and a principal target of the most disabling of all health problems afflicting working populations – depression, blood pressure, anxiety.

As the era of AI takes hold, the Forum foresees sweeping changes to the nature of work powered by a "Fourth Industrial Revolution" and the advent of what the CEO of IBM calls "new collar jobs". Among the countries likely to be most affected by job loss and rotations in the hundreds of millions, the Forum points toward China, India, US, Canada, Mexico, Germany will be among the hardest hit, in that order.

There is a consensus that the kinds of work that AI will take over might be classified as repetitive labor, scripted customer service and telemarketing, narrow fields of work like banking services, and jobs with no face-to-face human contact.

At the same time, the WEF highlights the value of what human beings, not machines, offer in the form of *creativity, understanding, handling complexity, adapting to new environments and, essentially, unscripted encounters requiring instinctual, discrete behaviors.*

Each of these requires healthy cognitive functions, and each demonstrates that the minds, not the backs, of employees do the heavy lifting for business in the 21st century. Anders Sandberg, Oxford University's "Future of Humanity Institute" puts it this way: "If your job can be easily explained, it can be automated, if it can't, it won't."

IBM Chief Executive Ginni Rometty says the "skills gap and job insecurity" relating to AI (and automation) are real." She says, "when we talk of a skills crisis, I really do believe that 100% of jobs will change."

The crisis, though, can be overcome. Ms. Rometty told the World Economic Forum at Davos that she wants to see the development of a new education and career model, new collar jobs, not blue or white. This means, she says, investing in skills development and responding in real time to changes in present and future jobs.

Without this, she forecasts social unrest.

At Davos, France's Minister of Labor, Muriel Penicaud, said her country was giving employees 500 Euros a year to choose training of their own choice. "Today, access to capital is easier than access to skills," she said, urging "pro-action. "

Meanwhile, the Canadian Institute for Advanced Research and the Brookfield Institute for Innovation and Entrepreneurship have built a roster of experts to measure the impact that automation is likely to have on Canadian jobs.

In the face of all this, it is predictable that chronic stress will be intensified by the vast infusion of AI into our lives. Stress is the combustible connection between the individual and the social and economic environment in which they live and work. On this basis, stress can predict mental distress and disorders.

The Canadian Mental Health Association has captured that dynamic in these words: *"Mental health is defined as a congruent relationship between a person and surrounding environments and systems … where the requirements and resources are congruent with needs and capabilities of the individual."*

Work Climates That Predict Lost Work

Stress can be harmful as it accumulates, outside of one's control such as unforeseen and perpetually tight deadlines, excessive worry about tomorrow, isolation from the team or the group, unrelenting peer pressure. Research by the Ontario (Canada) Institute for Work and Health found that job stress encountered "on the margin" – that is, at the end of the day, and taken home – is as big a threat to cardiac health as smoking.

Put another way: AI will be a carrier of man-made stress among working populations and their families. The Chief Scientist of Québec, Canadian neuroscientist, Dr. Rémi Quirion once called the discovery of why human beings are thus affected by stress a "Holy Grail" of scientific discovery. Stress, he says, is key to human survival but also destructive and damaging on a large scale.

Scientists at Harvard University surveyed a wide range of businesses in a cross-section of industries and found that the strongest predictors of days lost at work are "psychosocial" work climates. The term "psychosocial" can be taken to mean the emotional whiplash created by gossip, harassment, bad management practices such as micro-managing and uneven work distribution. In effect, how we treat each other.

In an economy that puts a premium on cerebral skillsets, stress is a workplace health and safety hazard as dangerous as unsafe equipment, sloppy work sites and polluted air. Dismantling these sources of stress means changing attitudes and behaviors among executives, managers and supervisors. Bell Canada and the Government of Canada (as an employer in its own right) have both incorporated fostering mental health in the workforce into the job performance standards of senior executives.

Stress Epidemic Commands CEO Attention

In the face of the stress epidemic, CEOs are being called upon to take on a greater leadership role in reducing the mental health burden among working populations. CEO Guidelines for Mental Health and Productivity at www.mentalhealthinternational.ca and www.targetdepression.com which would be useful in this context.

Describing "unsettled, dangerous times" for employers and employees alike, the Guidelines say, "business has a significant stake in helping to promote and protect the mental health and wellbeing of their employees."

The Guidelines encourage CEOs "to give your employees every chance to learn about and discuss mental health issues without fear or reluctance."

The Guidelines say "defusing myth and misperceptions of mental illness is ongoing work" and, in turn, beget what we call the "New Hard Skills of Management." to rid the contemporary workplace of a range of unhealthy management practices including unreasonable demands, withholding employee discretion, rejecting "out of hand" workload concerns, randomly changing priorities, the treadmill effect at work, and perceived unfairness on a perpetuated scale.

These management practices constitute the breeding ground for chronic job stress that can affect brain function similar to how a serious knock on the head can inflict a concussion. To counter corrosive management practices, the New Hard Skills of Management embody the building blocks of psychological health and safety at work.

The New Hard Skills of Management will be needed to lift up and render "ideas, inclusion, trust, loyalty and motivation as business tangibles in the era of AI and to recognize the border between healthy and unhealthy workplace indicators.

Healthy Workplace: fairness, respect, recognition, appreciation, job clarity, reasonable demands, inclusion, common purpose.

Unhealthy Workplace: frustration, distrust, anxiety, fear, tension, low morale, low commitment, chronic job stress and, classically bad and obsolete management practices.

Advancing Mental Health

Dr. David Duxton, research scientist at the Naval Health Research Centre in San Diego, California and an Associate Professor of Psychiatry, University of Washington in Seattle, wrote the introduction to a book entitled, 'Artificial Intelligence and Behavioral and Mental Heath Care.' Following are a few extracts:

Mapping the Human Brain

- *There are several research programs underway to capitalize on supercomputing advancements to map and model the human brain. The Blue Brain Project in Switzerland – is creating software to model the brain at the molecular level to simulate a biologically realistic model of neurons. Computer systems that simulate human brain have the potential to improve understanding of normal/abnormal human brain functioning.*

Modeling Psychiatric Illnesses

- *One future possibility of AI: modeling psychiatric illness and to test models of the course of development and outcomes of treatment. University of Texas scientists are modeling the development of schizophrenia on a super computer to simulate the excessive release of dopamine in the brain.*

The Nature of Consciousness

- *Building machines with human general intelligence has the potential to help us learn more about the mind of AI and even the nature of human consciousness itself.* Research is happening on human-robot interaction in healthcare settings and what people prefer in using intelligent machines for healthcare purposes.

Machine-Brain Coupling

- *Coupling AI technology directly with the human brain through invasive or non-invasive means may permit treatment of non-congenital blindness; improve general cognitive abilities; restore function to a damaged brain; expand the benefits of telehealth and, through sensors and biofeedback, customize clinical services.*

Meanwhile:

- Google Accelerated Science is using AI to help make diagnosing diabetic retinopathy easier by accurately interpreting retinal scans, possibly saving the eyesight of millions in India.
- The University of Toronto has put into place a Chair in Robots in Society to help the elderly maintain their independence through and with the help of robots.
- 'Augmented reality" technology --- (described as the super imposition of the elements of a virtual world upon the real one) --- is being developed to use in therapy for children with autism and/or for treating malignant melanoma. (Fraunhofer Institute, Germany).
- IBM reports on new research using AI and machine learning algorithms to identify "instances and severity of schizophrenia with a 74% accuracy.

Further:

A new discipline, "computational psychiatry" will help clinicians "access and treat patients more quickly". Interestingly, computational psychiatry can be seen as a tool for psychiatrists to move past reliance on "subjective" evidence of the presence of mental illness. In this area, the National Institute for Mental Health is assuming a significant leadership role.

According to the NIMH website, "the overarching goal" of the Institute's "Computational Psychiatry Program ' – led by Dr. Michele Ferrante - is to "identify and validate biomarkers and novel treatment targets relevant to the prevention, treatment and recovery of psychiatric disorders."

AI and Mental Health Innovations

AI instruments are being developed to improve access to early detection, improved care and treatment outcomes of mental ill health. For example, **Canadian Daniel Martz, CEO of Equinox**, is using machine learning and AI (**ML/AI**) programs to expand access to cognitive and mental health therapy through virtual means 24/7 in Canada's both official languages – a first.

This then feeds into a data base that will strengthen clinical decision-making, Mr. Martz says. The innovation will be used to monitor those with other chronic disorders, opening-up the possibility of deploying AI to help manage co-occurring depression and diabetes, cardiovascular disease and other co-morbid conditions.

California-based **MINDSTRONG,** co-founded by the former Director of the National Institute for Mental Health, Dr. Thomas Insel, has introduced technology that tracks biomarkers of mental illness digitally.

MINDSTRONG describes its innovation as "augmenting and extending existing care models" through a smart phone app that identifies individuals who may need immediate attention. Among other things, it provides "biomarker loading" to signal mood changes, insomnia, lethargy, eating problems, guilt feelings, concentration problems, psychomotor issues and even suicidal thoughts, connecting the individual with a mental health professional who communicates via the Smart Phone in real-time.

A separate innovation called **MIND.ME** "ambiently monitors behavior online as well as the user's interaction with the world and the people around them." Executive Chairman of the company is Patrick Cashman, former CEO of Lundbeck Canada and its Medical Director is Dr. Roger McIntyre, an innovative scientist-physician who sits on the board of directors of Mental Health International.

This technology assists in the "diagnosis and prediction" of a depression episode and creates a "circle of trust" among friends and family members who may be contacted when the signs of a depression episode appear. Further, the user will be able to see their current mood compared to the same time last year with the same data going to physicians and caregivers.

The focus, widely, is mapping brain circuitry so as to understand how dysfunction, disorder and disquiet happen and how this can be resolved." Other developments illustrate the promise of AI to elevate the prospects of difficult recovery. For example, Google Accelerated Science is using AI to help make diagnosing diabetic retinopathy easier by accurately interpreting retinal scans, possibly saving the eyesight of millions in India.

PAN-CANADIAN Strategy on AI

The Canadian Institute for Advanced Research (CIFAR) has been commissioned to produce THE PAN-CANADIAN Strategy on Artificial Intelligence. CIFAR, in fact, has played an historically significant role in AI research in Canada and around the world, enabling some of the fundamental breakthroughs in the field through its 'Learning in Machines & Brains program.'

In this light, CIFAR will explore the ways that AI will reshape our society and how we should respond. CIFAR Fellows are "studying the social underpinnings of wellbeing in numerous contexts, such as educational attainment, mental health and personal happiness." Computers that are better at understanding and learning from the real world could revolutionize medicine, industry, transportation, natural resources, healthcare and the arts, oil and gas production.

According to CIFAR's Annual Report: "The result will be computers that are not only powerful but intelligent and that will be able to do everything from conducting a casual conversation to extracting meaning from databases of information." Computers learning from the real world could revolutionize medicine, industry, transportation and our day-to-day lives and, in fact, CIFAR researchers are using deep learning to identify genetic contributors to conditions such as autism."

CIFAR CEO, Dr. Bernstein calls for steps to "combine AI thinking with new ways of medical diagnosis, new materials for energy harvest and storage and predicting the emergence and tracking of new viruses as the ZIKA and Ebola viruses. Last year, top academic researchers were named to AI Chairs as part of the $125M Pan-Canadian AI Strategy that will help maintain Canada's leadership in AI research.

CIFAR is working with the Brookfield Institute for Innovation + Entrepreneurship, which was launched in 2015. The two groups have built a roster of experts to measure the impact that automation is likely to have on Canadian jobs.

Québec Leadership in AI

Québec's Chief Scientist, Dr. Rémi Quirion, in 2018, issued a "call for Proposals" that led to the creation of the International Observatory on the Societal Impacts of Artificial Intelligence bringing together universities, colleges, research centres, governments and non-government institutions, business and other groups across the world.

The Observatory examines "AI and digital issues of concern to all spheres of society, the impacts on individuals and organizations and communities." More than 16 researchers will join "this new scientific hub." Leading this effort is Dr. Lyse Langlois, Director of Laval University Institute of Ethics and professor of industrial relations.

Professor Langlois describes her mission this way: "We will work together to improve understanding, better inform the public and help decision-makers as they grapple with the huge challenges this fast-growing field poses in terms of employment, health, education, technology, security, democracy, justice and ethics."

The Vice-Rector of Research, Creation and Innovation at Laval, Dr. Eugene Brouillet, adds this: "The challenges of AI and digital technology know no borders and demand global study and decisive action. The entire international research eco-system in this explosive new field have a role to play in the Observatory." McGill University in Montreal is also a partner in the Observatory and has assigned ten scientists to this work.

Meanwhile, Facebook is opening a new Artificial Intelligence Research Lab in Montreal to be led by Dr. Joelle Pineau, Co-Director of McGill's Reasoning and Learning Lab and she is one of the McGill researchers whose work focuses on social applications particularly in robotics in health, transportation and language processes.

Government Directive on AI decision-Making

Meanwhile the Government of Canada has instituted, as of April 1, 2019, an internal "Directive on Automated Decision-Making" designed to "ensure that automated decision systems are deployed in a manner that reduces risks to Canadians and federal institutions and leads to more efficient, accurate, consistent and interpretable decisions made pursuant to Canadian law. The Directive refers to "an automated decision system allows for human intervention … when appropriate."

The Directive is part of what the Government of Canada's Chief Information Officer Alex Benay describes as the government's strategic investment in the Canadian AI eco-system. He says investments such as this are needed as "AI has emerged as disruptive technology that is rewiring the way we interact with the world. - technology that is becoming more pervasive and will have profound impacts in the years to come."

Mr. Benay refers to the government's Cdn$125M investment in the Pan-Canadian AI Strategy and $950M for what he describes as a "superclusters initiative" to generate cutting edge research. He says the Government also recognizes that AI offers efficiencies in service delivery but also poses risks unless its use is "governed with clear values, ethics and rules."

G7 Stakeholders in AI

A discussion paper was authored for the G7 Multi-Stakeholder Conference on Artificial Intelligence on December 6, 2018 by a team representing the University of Ottawa, University of Tokyo and the Canadian Institute for Advanced Research. The paper spelled out the need for "accountability in AI but there is no consensus a among the broader community as to what an (accountability) toolkit would look like."

The Paper – requested by the Government of Canada – says (calmly) that "as with any new technology, we are learning that deploying AI beyond the lab can result in harm to individuals and societies" – including, the author of this report notes, the effects of biased data sets in creating discriminatory applications of AI, the difficult-to-control behavior of deep learning systems which function like a "black box" and people "over-trusting AI and leading to physical and mental harms."

"These systems are opaque and coupled with their potential use in critical high-stakes, decision-making context (such as judicial reasoning, war-fighting, financial transactions), their potential impact is significant." The G7 Discussion Paper says "anticipating and addressing these potential risks is urgent."

The Brookings Institute reports on the effects of AI and automation on "people and places" and calls for promoting a constant learning mindset, reskilling incumbent workers, fostering uniquely human qualities, future-proving vulnerable regional economies, reducing hardships for workers who are struggling, and focusing on AI-change as tasks not whole jobs to be taken over by machines."

Brookings: "Almost no occupation will be unaffected by technological change in the AI era. Some of the most vulnerable jobs are those in office administration, production, transportation and food preparation. High risk jobs will be those with over 70% of their tasks likely to be automated."

Meanwhile, we propose in this Report that a **"values, threat and mitigation**" process and protocol be developed for workplaces, specifically: an *'AI Values Affirmation Principle'* – establish and affirm the values that will guide implementation of AI; an *'AI Threat Measurement Standard'* – threats to these values and an *'AI Mitigation Process'* – to do and undo what needs to be done and undone to mitigate these threats to the values guiding AI implementation.

The University of Montreal brought forward "principles and recommendations" in the form of the "Montreal Declaration for Responsible Development of Artificial Development" with three core objectives: develop an ethical framework for the development and roll-out; guide the digital transition so everyone benefits; and open a national and international forum for discussion to achieve equitable and inclusive AI development.

The Declaration contains ten principles, among them, that AI systems must permit the growth of the wellbeing of all sentient beings (meaning people); all systems must respect the autonomy of people; and accommodate privacy, intimacy, democracy, diversity, responsibility."

In a dramatic development, based on a $100 million gift, the University of Toronto is creating Schwartz Reisman Innovation Centre and the Schwartz Reisman Institute for Technology and Science. These institutes will aim to advance AI and address the ethical and societal implications of AI and other emerging technologies," as reported in a full-page ad appearing in the New York Times.

In early 2017, a broad coalition of AI leaders signed the 23 Asilomar AI Principles, the first of which says that, "the goal of AI research should be to create not undirected intelligence, but beneficial intelligence". The Principles are the most widely adopted effort of their kind, having been endorsed by AI research leaders at Google DeepMind, Google Brain, Facebook, Apple and Open AI. Signatories include the late Stephen Hawking and more than 3,800 other AI researchers and experts.

The Future of Life Institute says this: "Profound societal impacts of AI are no longer a question of science fiction but are seen in many quarters from facial recognition technology to drone surveillance and the spread of targeted disinformation campaigns. Advances in AI are helping to connect people around the world, improve productivity and expand human insight. But AI may pose safety and security threats, exacerbate inequality and constrain privacy and autonomy."

PART TWO

Mental Health, Genetics, Epigenetics and
Social Science in the Era of Artificial Intelligence

A discussion of the implications of AI for the mental heath and wellbeing of people is incomplete without reviewing other topics of interest to mental health.

There is evidence that the fields of genetics, epigenetics, social science and Artificial Intelligence provide a plausible framework within which to build the case for the prevention of mental disorders earlier and later in life – this, based on the now well-established premise of genes + environment as key dynamic in the development and onset of mental illness.

In turn, this proposition opens a clearer path toward prevention through the reduction of deep stress at source in our living and working environments and the disciplines of social science, organizational health and business management are all relevant to the prospects of achieving this.

We will discuss these links here.

First, the terms "genomics" and "genetics" are often used interchangeably, but there are differences. Genetics is the study of specific genes or parts of genes whose function are known. Epigenetics, in lay terms, focuses on the interaction between our genes and the environments we are exposed to during birth and through life. From this interaction, disease occurs, and may be predicted and mitigated.

In 2013, Dr. Daniel Weinberger, Director of the Lieber Institute at Hopkins in Baltimore, told our 5th US/Canada Forum on Mental Health and Productivity in Toronto: "*Genetic discoveries represent the first absolutely objective clues as to what mental illnesses are at a very basic cellular level by which we might be able to predict and ultimately prevent individual risk status.*"

Dr. Steven Hyman says that investments in genetics are important and timely. "Well-designed human genetic studies, carefully interpreted, are proving a direct route to elucidate psychiatric disease mechanisms. " This, he says is "a critical step toward the significant goals of advancing biomarker discovery and new, effective therapies".

Spectre of Unintended Consequence

Meanwhile, Genomics is said to be the study of the entirety of an organism's genes (the genome). This includes studies of DNA-sequence data which can identify variations that affect health, disease and drug response. Synthetic biology is a branch of genomics which, like AI, has been branded as both promising and perilous.

Synthetic biology encompasses tools and methodologies to write DNA. The study of synthetic biology and genome editing are part of this discipline. At the heart of synthetic biology is the quest to solve problems. Ontario Genomics touts it as a way to fight viruses, overcome food shortages, combat climate change.

Just as in AI, advocates and practitioners in this field are using nomenclature which reveals an ambiguity about what their end product will actually entail. In the case of Ontario Genomics, we come across plans to design and engineer "new biological entities to cure diseases, mitigate climate change and substantiate global sustainability."

The vision is appealing. The results, if achieved, could be beneficial beyond one's imagination. Does the process, however raise questions as to whether the human being will be re-defined or augmented in a way that changes the premises of human identity in unintended ways?

Once again, as in the case of AI, the spectre of Unintended Consequence rears its head.

Synthetic biology is already being used to replace petrochemicals in some products, and plants are being developed to replace meat in hamburgers, all good things. However, synthetic biology could also be used to develop pathogens that can threaten human beings.

An editorial in the April 6th, 2019, edition of the Economist Magazine foresees "synthetic biology (having) a cascading effect (on society), transforming human relationships and potentially, the biological nature (of people.)" Foresight is called for to unleash the "promise" and contain the "peril" of synthetic biology.

Epigenetics: Path to Solving Mental Disorders?

Epigenetics offers a deeper well of potential for the outright prevention of mental disorders even before the onset of symptoms. Epigenetics is, at last, providing the means to prevent disease and mitigate its effect, unlocking the relationship between the human genome, the environment, prenatal exposure and disease risk across the lifespan.

New scientific knowledge points to childhood, or earlier, as the "ideal time" – possibly preceding symptoms by years - for interventions to prevent mental illness. In future, one of the most powerful and precise tools for interventions to alter brain circuit activity – which is where mental illness happens– may well be targeted psychotherapy.

The magazine 'Psychology Today' describes epigenetics like this: "It used to be thought that we were born with a fixed genetic blueprint that determined our traits, behaviors and health. Now, discoveries in epigenetics have radically rebooted this theory."

Research funded by the National Institute for Mental Health says "the ultimate goal of epigenetic studies of mental illness is to understand how genetic vulnerabilities interact with an individual's life experiences … to establish changes … that control the levels of gene expression. Epigenetic studies are providing new insights into inheritable and non-inheritable components of mental illness."

A news release by McGill University – a world leader in epigenetics – says "epigenetics is the study of changes in the way information stored in the DNA is expressed. Some epigenetic changes are part of normal development and aging but environmental health scientists are most concerned with studying how environmental factors can cause negative epigenetic changes (disease)."

Unlocking Secrets

According to experts consulted for this report, epigenetics can at last unlock the relationships among the patient's genome, environment, prenatal exposure, and disease risk in time to prevent diseases or mitigate their effects before they take their toll on health.

Epigenetics stands at the intersection of the genome, human development and environmental exposure which can have a profound effect on susceptibility to disease. Dr. Danielle Fallin, Head of the School of Mental Health at Johns Hopkins University, in a written article, shared the view that genetic predisposition and environmental influences shape risk for nearly all forms of disease – risk that typically increases with age.

McGill pharmacologist Dr. Moshe Szyf says, "new data is breaking the bonds of genetic destiny." That is, experience and environment intermingling with our genetic selves change the way those genes are expressed, producing what Dr. Szyf calls an "epigenetic imprint." This, he says, might explain why underweight babies born to malnourished Dutch women during World War Two gave birth of underweight children decades later.

There is also evidence that victims of the great Soviet famine gave birth to children who, decades hence, gave birth to children with above average incidence of schizophrenia. Both instances demonstrate the impact of diet on human health in a dramatic way. But the day-to-day experience, over time, can produce unhappy results as well.

Epigenetics is said to open what some leaders in the field call a new era in the "prevention and mitigation of disease" – including mental illness. Dr. Gustavo Turecki, Scientific Director, Douglas Hospital Research Centre and Chairman of the Department of Psychiatry, is an expert in epigenetics.

In an interview for this report, Dr. Turecki replied "categorically, yes" to the question as to whether there is an epigenetic basis of mental illness. He said, "absolutely epigenetics has much to do with mental illness in that epigenetics is concerned with how the genome is regulated to adapt organisms to the environment."

"Everything is mediated by epigenetics (which) is essential to understanding how stress and mental illness happen," Dr. Turecki said, adding that AI will be an important tool to analyze "millions, even trillions of data points" as the cellular components of mental illness are probed to learn – ultimately – how mental illness happens and how it can be prevented.

Some of the earliest research in epigenetics occurred at McGill, a world leader in the field. In 2012, the "Canadian Epigenetics, Environment and Health Research Consortium was formed at McGill, a partnership of Genome Quebec, the Canadian Institute for Health Research and the Government of Canada.

**Triangulation: Epigenetics, Artificial Intelligence and Mental Health (T>E>A>M)**

Given the hopeful dimensions of epigenetics as an instrument of discovery, the potential of AI as a strategic scientific tool, and mental health as an economic asset, one can visualize a triangle or trinity containing:

Epigenetics as, ultimately, a new source of clinical insight into the early intervention, even prevention of mental illness by identifying/pre-empting gene+environment risk;

A**rtificial intelligence** as a source of future innovations to fight mental illness and, at the same time, a source of "gene+environment" risk that may worsen the problem;

M**ental health** as the source of productive workplace capacity in a brain-skilled workplace – and the source of coherence in the human vessel and society itself.

The following graphic demonstrates this:

Mental Health in the Era Artificial Intelligence
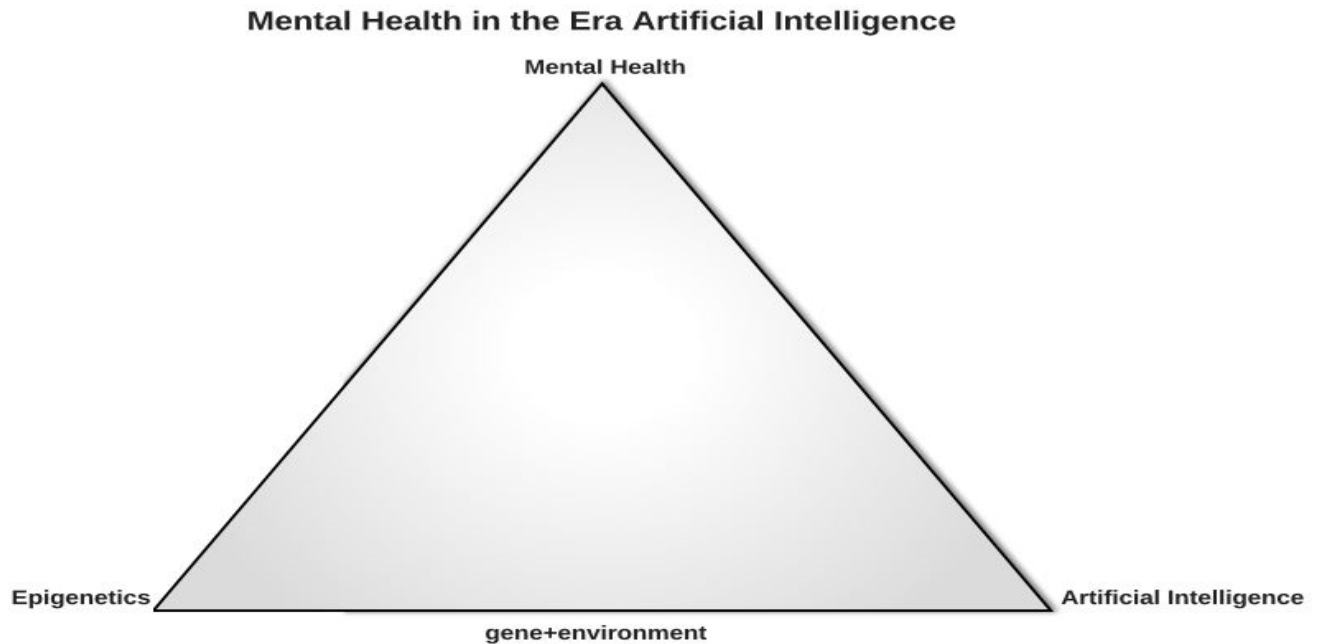
Designed by Shannon McCoy, Ottawa, Ontario, Canada

Stress: Cause of Psychiatric Disease

In the light cast by advances of epigenetics, we now have a scientific premise to affirm what was generally acknowledged a long time ago, that the environment which humans inhabit – interacting with our genes – produces the causative effects of mental illness. With this firm knowledge in hand, it seems logical to conclude we also have the rationale for attacking the cruel family of conditions called mental illness through accelerated investments in epigenetic research.

As knowledge of the interaction between the environment and genes as a source of disease risk grows, science and society can use these inroads to leverage greater investment in analysis and research to document the 'how and why' stress plays such a heavy-duty role in generating risk.

Therefore, possibilities exist to prevent the deadly and disabling effects of mental illness by – in part, at least – reducing social and economic environmental risks, behaviors and outrages and by seeking who is at risk – and at risk of what – through the lens of the human epigenome and the human environment.

One interesting note: disease can now be seen as "epigenetic marks" that may, in fact, potentially, be undone or removed. This presumably raises the possibility that new treatments, lifestyle adjustments or environmental changes may reduce the risk of developing mental illness.

Research appearing on the NIH/NIMH website points to the effect of "environmental insults" on (brain) neural circuit function and ultimately behavior. While epigenetic studies of depression, schizophrenia and bipolar disorder are at early stages, it is already known that environmental factors recruit the epigenetic machinery of human beings within specific brain regions to create susceptibility to disease."

An Answer to Schizophrenia?

The NIH/NIMH website: "we have learned from all this that genes and physical characteristics of the brain <u>do not operate outside of</u> <u>influence from the environment</u> and …. by influencing the environment we live in, we can have a positive influence on how a brain works and continues to grow."

Against that backdrop, there is a series of other transformative developments that will help change – in historical ways – how science, society and individuals perceive and approach mental health problems. One source of this transition to the future is the biggest-ever genetic study of mental illness as reported in "Scientific American."

Research by the Working Group of the Psychiatric Consortium studied 37,000 people living with schizophrenia and found 128 variants associated with the disease in 108 locations in the human genome while another NIMH-funded study discovered a possible "neural signature - a pattern in the way a brain circuit works - that may help predict the onset of psychosis."

This points to the prospect of identifying people who may benefit from early intervention but also "<u>the findings may also hold clues to the underlying brain mechanisms involved in schizophrenia.</u>" Versions of a gene linked to schizophrenia may trigger runaway pruning of the teenage brain's still maturing communications infrastructure.

A team of scientists at the Broad Institute and Harvard Medical School analyzed the genomes of 65,000 people plus postmortem brains "to discover the secrets of schizophrenia's strongest known genetic risk, a gene called C4."

Described as the "tallest tower of schizophrenia's genomic skyline," scientists found that C4's role represents the most compelling evidence to date linking specific gene versions to a biological process that could cause the illness."

Their report says, "the human genome is providing a powerful new way of prying open (this disease), peering inside and starting to see actual biological mechanisms of schizophrenia." Dr. Bruce Cuthbert, former Acting Director of the NIMH, now Head of its influential Research Domain Criteria (RDoC), in a public news release by the Broad Institute, declared these findings "a crucial turning point in the fight against mental illness. "

"And thanks to this genetic breakthrough," he says, "we can finally see the potential for clinical tests, early detection, new treatments and even prevention."

Dramatic stuff.

Boundaries of Mental Disorders

Prevention of the disabling and deadly effects of mental illness is likely the most promising course for the future. Dr. Christine Ladd-Acosta, Assistant Professor, Johns Hopkins Bloomberg School of Public Health, says the first step is knowing which specific places in one's genome will contribute to risk.

"I am trying to see some of the courses of disease and if I can identify them, we could prevent them from happening. We know that in mental health disorders, there is a genetic component, but the environment contributes to risk as well, so it is likely both".

The results of numerous studies have made strong arguments that the boundaries among many disorders are more fluid over the life course than psychiatric guidelines have recognized up to now. It is now known that many symptoms assigned to a single disorder may occur, at varying levels of severity, in many other disorders.

The preamble to the Diagnostic Statistics Manual (DSM-V) says "it is anticipated that future clinical and basic research studies will focus on mental illnesses as "dimensions" or spectrums of symptoms rather than the more narrowly-defined and exclusively-labeled "disorders."

New Research Domain Criteria

The US National Institute of Mental Health has concluded that the current designations of mental disorders for diagnostic purposes do not represent "valid disease entities". In a dramatic move, the NIMH has re-written its rules for funding mental health research, introducing new "Research Domain Criteria" (RDoC) to incorporate genetics, neuroimaging, and cognitive science into future diagnosis based on neural systems.

One compelling reason for this change is that the diagnostic guidelines for mental illness – contained in the Diagnostic Statistics Manual (DSM-V) -- show almost no influence of the remarkable advances in new technologies and substantive knowledge in neuroscience and behavioral science since release of the DSM-IV in 1994.

The new NIMH framework incorporates neurobiology into whatever causes and whatever constitutes mental disorders – that is, what is normal and abnormal in the function of the human brain. Over the past two decades, NIMH and other agencies have funded research to understand mental disorders as brain disorders, increasingly recognizing these conditions as neurodevelopmental disorders starting in fetal or early post-natal life.

Symptoms, however, may not manifest for years or decades and this means the ideal time for intervention may precede symptom onsets by years.

Comparable Risk for Several Disorders

Based on this view, one might conclude that a new classification system will be based on this key discovery, that illnesses such as depression, bipolar disorder and schizophrenia will no longer be considered watertight compartments. The reason being: science has found common genetic variances.

The Psychiatry's Consortium Working Group analyzed data from 135,000 people with major depression and found multiple genetic changes working together to increase the odds of developing depression. Up to now, research had identified only 14 genetic spots associated with specific genes connected to depression.

By examining 9 million single gene mutations, the Consortium identified 44 statistically significant genetic spots involved with depression. The Consortium also found that depression's genes overlapped with 6 genes linked to schizophrenia. Before this finding, scientists had uncovered only 14 genetic spots linked to depression.

In the largest genetic study of mental illness up to 2013, researchers found that five major disorders share gene-based variants and yet manifest in different ways. These are autism, ADHD, bipolar disorders, major depression and schizophrenia.

Meanwhile, researchers at the University of Denmark found that "psychiatric illnesses are connected." They say, "the concept of shared inheritable risk underlying mental illnesses could lead to a paradigm shift in drug discovery targeting root causes."

Dr. Anne Bassett is head of Clinical Genetics at the prestigious Centre for Addiction and Mental Health in Toronto, and says: "we are all born with genetic risks or vulnerabilities and fully one half of all our genes relate to our brain and nervous systems and are the most important part of causation of serious mental disorders".

Dr. Rémi Quirion, concludes that the combination of "genetic predisposition" and social environment ("gene + environment") including stress, trauma, lifestyle and nutrition likely determine one's risk to depression, anxiety and other conditions.

Prevention Starts in Childhood

These developments may well establish the basis of preventing mental disorders from the pre-natal period through childhood. Dr. Marisa Young, Assistant Professor, Depart of Sociology at McMaster University, logically, argues, therefore, that the concept of prevention must extend beyond the workplace to the family.

Signs point to mental illness as a "neurodevelopmental disorder with changes occurring in fetal or early post-natal life" but "with symptoms that may not manifest for years or decades." This means the ideal time for intervention may precede symptom onset by years.

The goal of the new NIMH Research Domain Criteria (RDoC) is to "understand mental disorders as deviations from the normal functioning of brain systems rather than continue with inadequate symptom-based definitions."

All these issues demand unprecedented collaboration across many scientific disciplines from neuroscience, medicine, genetics, epigenetics and mathematics, social sciences, economics, physiology, cognitive sciences and AI.

"European Roadmap" Follows Similar Route

For similar purposes as the RDoC initiative, the European Commission funded a Roadmap for Mental Health Research and the European Union Innovative Medicines Initiative advocates linking psychiatry with neurobiology. Called ROAMER, this initiative has led to new efforts in Europe to transform diagnosis.

Further, an accelerating body of literature over the past decade calls for a "new clinical system for mental illness based on biology as well as (clinical observations.) This would demand an overhaul of conventional thinking of health care providers, government and regulatory agencies, granting agencies and so on.

Nonetheless, the NIMH Research Domain Criteria opens the door to "new thinking" about what mental illness is, and what it isn't. Recapping these points for emphasis:

- Serious mental disorders increasingly appear to be neurodevelopmental which means symptoms develop early and progress over time;
- Mental disorders are brain circuit disorders resulting from a wide variety of problems in the maturing of the human nervous system from conception.
- The social and physical environment in which people grow up, live and work can – through life -- constitute both risks to mental health or a protector of it.

The transformative approach to more effectively managing mental illness has been embraced by leading Canadian scientists at the Centre for Addiction and Mental Health in Toronto. There, Dr. John Haltigan is "searching for why some of the most hard-to-treat or pervasive mental illnesses – from autism spectrum disorder to depression - occur among children and young people."

His work is described as "being part of a larger movement to break apart existing definitions of mental illnesses into their underlying components – into the symptoms, behaviors and biological factors associated with mental illnesses." Thus reflecting further movement away from current labels. "The standard approach" Dr. Haltigan says, "defines mental illnesses as though they are discrete entities but many – if not most – occur in multiple disorders.

"In a single categorically-defined mental illness, there can be a wide variation of symptoms," he says. The Centre for Addiction and Mental Health is Canada's largest mental heath teaching hospital and, there, Dr. James Kennedy is carrying out research dedicated to finding genes involved in the cause of mental illness.

A report, "CAMH IMPACT", says the "current trial and error method for prescribing medications often results in non-response and/or side effects. Only half of patients respond to initial treatment with prescription medication. Dr. James Kennedy and his group from the Centre have found that pharmacogenetic testing of liver enzymes is clinically useful in prescribing medication. Personalized prescribing ensures patients receive maximum benefit."

PART THREE

The Biology of the Human Mind

The Brain and Behavior: Is that all there is?

There is quite naturally some discomfort among people to think about their thoughts, feelings, perspectives, fears and apprehensions as biological functions performed by the human brain. Where is the human spirit in all this? Where is personal accountability? Where is religious faith? Where is belief in something greater than one self? Are all of these things just biology?

The author of this report makes no claim to know the answers to these questions, but he recalls one of Canada's greatest neuroscientists, Dr. Philip Seeman, once recounting that when he was with patients who died, he noticed that the "glisten in their eye" was the last to leave. He wondered aloud, could that be the departure of the soul? If a world-renowned scientist can ask such a question, so can we all.

Combined with medicine, psychology, business and economics, we might find an integrated model of inquiry that will get us closer to understanding why human beings treat each other so cruelly on such a large scale and why violent behavior mostly - in overwhelming numbers - is not due to mental illness but is assumed to be.

Mental illness is rarely involved in violence, and when it is, the person living with mental illness is likely the victim or when psychosis, a mind-state produced not by mental illness only, but also by drugs, alcohol and isolation, dominates that person's deluded thinking. One form of mental illness where psychotic "breaks" can happen (increasingly less so, by the way) schizophrenia, afflicts less than two per cent of the population overall.

In most cases of mass violence of the nature we see too often, the trigger is deeply-seeded anger, alienation and isolation, not mental illness.

Moving From the Mysterious

The legendary Dr. Eric Kandel writes that science is moving from a decade concerned with probing the mysteries of brain function to a decade of exploring treatment for "brain dysfunction".

"What we are learning about autism, schizophrenia, depression and Alzheimer's Disease can help us understand the neural circuits involved in social interactions, in thoughts, feelings, behavior, memory and creativity just as surely as studies of these neural circuits can help us understand brain disorders. In a larger sense, much as the components of a computer reveal their true functions when they break down, so the functions of the brain's neural circuits become dramatically clear when they falter or fail to form.

"The processes of the brain that give rise to our mind can become disordered, resulting in devastating diseases that haunt humankind (autism, schizophrenia, depression, Alzheimer's Disease, Parkinson's Disease and Post traumatic Stress.)"

The biology of mental illness is not confined to the brain. It migrates into the body. Clinical evidence points to a free trade of complications between brain and body – between mental illness – especially depression – and disorders such as cardiovascular disease and diabetes. This establishes a brain-body continuum governing mental health problems and treatment outcomes among other chronic, concurrent disorders.

Mental Health International developed a MATRIX to display the connections between depression and these various conditions and, therefore, the brain-to-body effects of this common mental disorder.

Mental Health International developed a MATRIX (PAGE 26) to display the connections between depression and these various conditions and, therefore, the brain-to-body effects of this common mental disorder.

THE DEPRESSION MATRIX
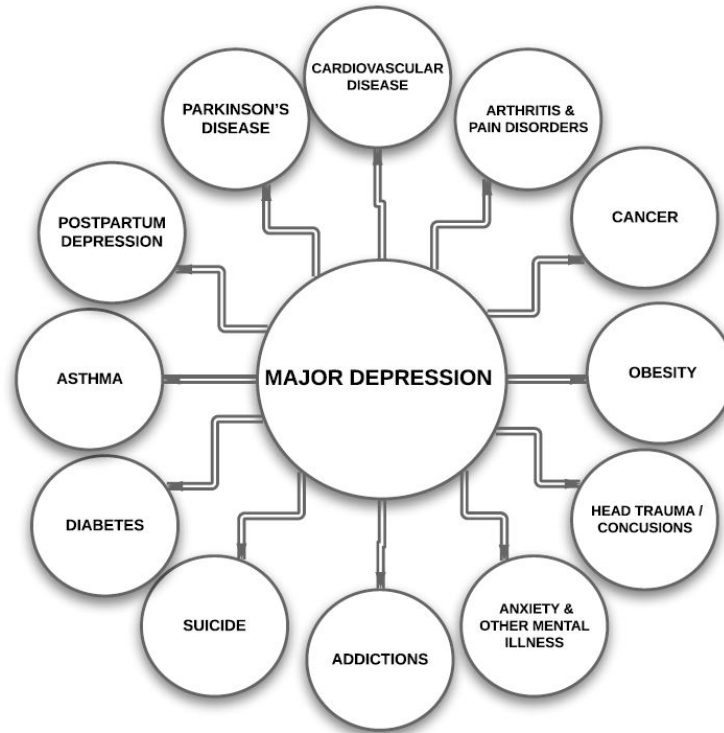
Designed by Shannon McCoy, Ottawa, Ontario, Canada

As Big as a Country

New data demonstrates that mental disorders are compromising gains in life expectancy that the world has achieved over the past 50 years. Indeed, Americans living with major mental illness in several US states have seen their lifespan fall below that of Sub-Saharan African countries with emerging economies such as the Sudan (58 years) and Ethiopia (52 years).

What are these people dying from? What we are all dying from. Let us examine the details behind the Matrix. For one thing, mental illness is heavily concentrated among men and women in their prime years of work - plus their adolescent children. Thus, the well-documented heavy economic cost burden imposed by these conditions.

If mental illness was a country, it would be among the world's ten most populous. Notably, as the insurgency of mental illness across the globe took hold over the past 20 years, other public health trends also emerged.

Landmark article for Foreign Affairs magazine by Dr. Thomas Insel, former Director of the National Institute for Mental Health, and Dr. Steven Hyman, Director, Stanley Centre for Psychiatric Research at the Broad Institute of MIT and Harvard tells us:

- Infectious disease has given way to chronic non-communicable disorders as the principal public health concern of the times and as a result, non-communicable (or chronic) disorders, such as heart disease and diabetes and depression, now pose a greater public health risk than contagious or infectious diseases.

- The Harvard School of Public Health's (updated in 2010) Global Burden of Disease Report revealed that non-communicable diseases caused 63 per cent of all deaths around the world, mostly in low- or middle-income countries.

- The Global Burden of Disease report said that between 2010 and 2030, chronic, non-communicable diseases will reduce global GDP by $46.7 trillion (US)

- The biggest source of those future costs are mental disorders, representing, by 2030, one-third of the global economic burden of all non-communicable disorders - $6 trillion (US). More than heart disease, cancer, diabetes and lung diseases combined.

According to the London School of Economics nearly a third of all people with long-term physical conditions have co-morbid mental health problems like depression and anxiety and mental disorders are clearly the "most important" health challenge among working men and women.

A Chain of Complexity

Following is a brief review of the co-morbidity between mental illness and other chronic disorders as captured by various scientific reports, summaries and studies beginning with a report by Harvard University researchers:

"Depression is both biological and social in origin. Causal pathways that transform social experiences into (mental illness) are unknown.

"Current research provides strong evidence that all mental disorders are biosocial and that whatever psychological processes are involved, the quality of a person's social environment influences both vulnerability to, and the course of mental illness.

"Mental illness is not simply symptoms of broader social conditions, nevertheless, poverty, lack of security, violence, lack of healthy family relationships during childhood and the trauma of significant loss are crucial factors for mental illness.

"Mental illness is most often found in constellations that bind together biological forces, social conditions, cultures and (other) particular forms of illness. (That said), the correlation of job loss and recession and increased rates of suicide and hospital admissions for mental illness demonstrate a link between the two."

Other findings and statements concerning the cross-over between mental illness and other health conditions. Depression and coronary artery disease have a bi-directional relationship and depression may contribute to sudden cardiac death. (Montreal Heart Institute, Ottawa Heart Institute, Mayo Clinic, others.)

Depression and bipolar disorder increase the risk of coronary artery disease which ultimately causes heart attacks. (Dr. Benjamin Goldstein, Sunnybrook Health Sciences Centre.)

As a result, the world's top killer, heart disease, and its greatest disabler, depression, now constitute a powerful one-two punch to productive capacity in the workplace. (Global Business and Economic Roundtable on Mental Health.)

(Dr. Salim Yusuf, one of the world's great leaders in cardiology at McMaster University, hopes to do the largest ever - 200,000 subjects - study of the co-morbidity of depression and heart disease to determine if these conditions are, in fact, bi-directional or does one lead to the other.)

Diabetes raises the risk of dying from cancer and 80% of those living with diabetes die from cardiovascular disease and depression is linked to both. (New England Journal of Medicine, Canadian Diabetes Association).

Depression is associated with faster tumor progression and shortened survival time among cancer patients. (Supportive Oncology Magazine).

The Kings College Institute of Psychiatry in London, reports that "people with serious mental illness have lower cancer survival rates than the general population."

Several forms of mental illness occur with multiple sclerosis, the most burdensome are depression and anxiety. ("Neuro Transmission (magazine) – Essential Management of MS."). And greater levels of a brain protein (monoamine oxibase) may explain why postpartum blues and clinical depression are so common after childbirth.

Further:

- People with depression may have triple the risk of developing Parkinson's Disease and depression occurs in 45% of those living with PD. (American Academy of Neurology and the Journal of Neurology.)

- The worse pain gets, the greater the risk of depression (Cleveland Clinic) and people with psoriasis who are diagnosed with depression are 37% more likely to develop psoriatic arthritis. (Journal of Investigative Dermatology.)

One of the most striking findings in the area of co-occurring depression and cardiovascular disease is the singular impact of youth. A 2015 study for the American Heart Association – with Canada's Dr. Roger McIntyre on the study team – found that depression and bipolar disorder constitute a "moderate risk of cardiovascular illness among young people.

Further, in a major epidemiologic study, 50% of adults with mental illness described onset by age 14; 75% by age 24, explaining much of the tragedy of teen and young adult suicide. Turning to this tragic subject.

US Suicides "Skyrocket"

In Europe and the US, suicides spiked in the wake of the 2008 financial crisis, reversing an opposite trend that had set-in before then. Every year 45,000 Americans kill themselves.

When it comes to suicide, men die the most, women try the most. Suicide is the leading cause of violent death in the world today and, in the US, guns claim more lives through suicide than murder.

The increased risks of suicide in the wake of the 2008 financial crisis prompted the Bank of England to declare war on the stigma of mental illness in support of employees who experienced major stress and worse post 2008.

World Health Organization data shows that following the great recession of 2008, nearly all societies in Europe experienced rising suicide rates. These can be looked upon as the fatalities of a man-made financial crisis.

Similar trends were recorded in North America where suicides increased 4.5% in that same post-crisis era. Bloomberg News reported: "the world of high finance has historically been prone to a spike in suicides during and after intense crises."

"The concern now is that the aggressive and punishing culture of the financial services industry may be inflicting more permanent damage and suicide rates are a harbinger of this trend."

Very recent research has isolated a specific gene as engaged in suicidal thought and suicidal action – although there appears to be different manifestations of brain function and between these two states. Even with knowledge of the genetic influences from within the genome, the epigenetic influences – gene + environment – must be taken into account.

Epic Loneliness

Since connectedness is now big business, it is ironic that isolation and loneliness have become a sign of the times. Frequently at the expense of human life. An oft-cited 2015 meta-analysis from researchers at Brigham Young University showed loneliness and social isolation are as deadly as obesity and smoking and a lack of physical activity.

Why is loneliness so toxic, one writer asks? One reason, scientists are finding, is that it is form of stress known to have a wide range of health consequences including high blood pressure, poor diet, no sleep. A wealth of research shows that "a sense of being cared for and loved is crucial to our well-being" – as vital as air to breathe, oxygen, equality, thriving relationships. "

Dr. Parminder Raina, Head of the Institute of Aging at McMaster University, says "social isolation is all about" vulnerability to mental health problems and is linked to all aspects of mental illness. He says the "prevention of risk" is key to healthy aging – specifically, the prevention of "cognitive changes early in life."

Malignant Sadness

As cancer is a malignant growth, so depression is a malignant sadness, to borrow the title of a forthcoming book on the subject by Lewis Wolpen, a British biologist who has had the disease. Modern bio-medicine has tracked both cancer and depression back towards their molecular roots, but, as yet, the world's burden of suffering in both cases has eased only a little.

Fifteen per cent of severely depressed patients kill themselves; two-thirds contemplate suicide and "Steps Toward Suicide", based on an analysis by Mental Health International, are these: emotional isolation, loss of self-esteem and usefulness, loss of motivation to live, joblessness, impulse, drugs and alcohol, desperation, family history, among kids an altered perception of death and dying, social disadvantage and grievance.

 The chain reaction inherent in these ten steps can be broken. Among the most important tools we have in doing so are friendship, love and actual human connection (not via a hand-held device).   The World Health Organization has estimated that globally:

- More than 1.6 million people died in violent circumstances in the year 2000 and, of that total, 815,000 died by suicide, 520,000 were murdered and 310,000 died in armed conflicts including terrorist attacks.

29

- Expressed another way, "one person in the world commits suicide every 40 seconds, every minute, there is a murder and someone dies as a result of armed conflict every 100 seconds."

"Killing ourselves faster than each other"

Which means that as many people died by their own hand than were killed by someone else. The WHOs Etienne Krug summed it up this way: "We are killing ourselves at a much greater rate than we are killing each other."

In late 2018, the Economist Magazine reports that suicides in the US skyrocketed by 18% while globally, suicide has declined by 29%, saving nearly three million lives.

The suicide crisis in the US is rooted among "white, poorly-educated men in areas that were left behind by booms and crushed by bust." The New York Times' esteemed columnist, David Brooks, reported on latest data showing that suicide rates all over the world have risen by over 30% this century, that teenage suicides are twice that.

PART FOUR

Interpretations and Conclusions

Recommendations based on this report are set out in the opening section, "Introduction and Summary." However, additional thoughts are offered here.

It is notable that the risks of AI as set out in this paper have been cited by proponents not opponents of AI. On this basis, one can conclude that AI represents <u>a clear and present danger</u> to the brain-based mental health of working populations and their families.

At the same time, certain technologies and applications of AI are now being developed that will help individuals, families and clinicians to better manage emotional distress, brain-based symptoms and the discerning physical effects of mental illness. Thus, the 'promise and peril dichotomy' of AI.

Further, as epigenetics delvers further into the molecular basis of mental illness to pin down the mechanisms of development and onset, AI will be a powerful tool for analyzing the immense number of data points that will accumulate through epigenetic investigation.

On a larger scale, research is already underway to dig deeper into the mysteries and maladies of the human brain as it reveals itself and its dysfunction through mental illness. Using AI and other technologies, science will ultimately discover ways in which to map the human brain, the dynamics of mental illness and will one day get us closer to the means to prevent mental illness by reducing risk even well before symptoms appear.

What is needed then - in the light of this "promise and peril" - is a comprehensive international, well-coordinated public inquiry into the penultimate risks and opportunities that AI presents in terms of increasing or decreasing the mental health burden expanding across the world.

There are many vehicles already travelling the AI circuit that could absorb such an inquiry including the tremendous work being done internationally and nationally by the Canadian Institute for Advanced Research and its allied units. In some respects, CIFAR has already embarked on inquiries of this nature.

This report contains an informative basis for incorporating brain-based mental health into all this work. After all, the brain houses human intelligence and without that, the model for AI doesn't apply. Needed are standards,

policies and practices that are prominently posted in every workplace, in every market place and at every turn that the human being and our natural environment are the "precious cargo" of life on this planet.

We find guidance for articulating this in Canada's Charter of Rights and Freedoms which says Canadians are free to have their own thoughts and be unto themselves as they determine and decide, subject to the same rights and freedoms of others. In this light, the idea that smart machines would be a welcome intrusion upon these precepts is both outlandish and unacceptable.

Turning to Genetics and Epigenetics – three things:

1. Genetics has given us the first basic, molecular clues of the causes of mental illness and the newer science of epigenetics – the bridge between our genes and our environments – is providing a strong scientific basis for our understanding that the environment dominates the risk of disease including mental illness. I

   In turn, stress is the "overwhelming even dominant" cause of mental illness.

   Meanwhile:

   • A genetic breakthrough in scientific understanding of schizophrenia is opening the way for new clinical tests, early detection, improved treatments and even prevention.

   • Genetics has given science new information on genetic variants shared by differently "labeled" disorders demonstrating that these conditions (depression, bipolar, schizophrenia, others) are not watertight compartments. This information will lead to a new system classifying mental disorders and a better-illuminated path toward treatments and interventions that work.

2. Epigenetics stands out as a hopeful instrument of discovery to rip away the facades of social and economic environments that impair human health by generating hostile, chronic stress. One day, epigenetics may well help answer how and why stress inflicts such damage. Even as a distant star, this proposition presents some tough truths.

   • The kind of atmosphere and environments we create for everyday life and work, the way we treat each other, relationships at work or at home, the oppression we place on others, the confusion we spread and the anxiety that that breeds, the fear we engender, the political rhetoric we deploy, the bullying we inflict, the trauma we impose upon children, the cigarette we smoke or the drink we take while pregnant and –

   • The abuse and intimidation we hurl at each other through social media, the diet we live by and could die from, the hurry and the worry about the job, about globalization, the "pain drug" epidemic, struggle to juggle duties and commitments: these are all human traits and behaviors that are born of and <u>feed into</u> the stress epidemic that attacks the human mind, body and spirit.

3. Despite all this, scientifically and societally, we chronically "under-invest" in "stress". Why is that? Are we so familiar with the whole "business" of stress that we presume we already know enough about it, or that stress is the unavoidable price of admission to and badge of honor for a busy, successful life.

Some Concluding Observations

Dissolves Stigmatic Absurdity

Mental illness has biological roots and is a chronic disease with both physical and psychological effects. The distinction between "mental and physical" health problems is mute and inaccurate. The mental and physical are one. The brain and the body are one. The gene + environment connection is very likely how mental illness happens and this fact dissolves the stigmatic absurdity that mental illness is the fault of the person suffering it.

Apprehensions of a New Reality

AI may well be the harbinger of a global skills crisis unless prevented through employee re-training and skills re-development. That said, the apprehension and the reality of AI-based job displacement and job security may be two different things. The fact is the former can do damage and the latter will.

Nomenclature (1)

The nomenclature of AI must be calibrated so as not to imply or communicate any ambiguity among AI designers and users as to the clear distinction between the superiority of human beings and functional purposes of AI.

Terms such as "sentient beings" and "biological brainpower" are self-revelatory as to the inference they draw. That is, terms of this nature replace the simple clarity of "people and persons" and imply that the distinction between people and machines, for these purposes, is unclear. Ambiguities of this nature are chilling.

Arguably, the phrase "AI" should be dispensed with, as it sets up a false equivalency between machines and people through the inevitable "partner phrases" AI and human intelligence.

Nomenclature (2)

The nomenclature of mental illness is likely to change as a new classification system emerges on the strength of scientific and clinical recognition of these conditions as a spectrum not highly-distinct, water-tight compartments and labeled as such.

At the same time, the term mental illness, *per se,* is heavily and probably hopelessly stigmatized. A look at the synonyms for mental illness ('crazy, lunatic') that are listed by on-line dictionaries demonstrate how entrenched the stigmatization of mental illness is in our culture. A topic for another day.

In both mental health and AI, reforming the nomenclature crisis will lead to broader reforms of a cultural nature within the fields of science and technology.

bill.wilkerson@mentalhealthinternational.ca

BILL WILKERSON,

Executive Chairman, Mental Health International. February 2019

Bill has been working on mental health issues since 1998 with the late Michael Wilson, Canada's former Minister of Finance and Ambassador to the United States. Michael and Bill developed and published the first-ever 'Business Plan to Defeat Depression' in 2000 in association with the Dean of Health Sciences at McMaster University. It attracted national attention in Canada and news coverage in the US and Europe having been released in Toronto and Geneva at the World Health Organization. The two men also calculated the economic impact of mental illness in Canada, a first at that time.

Michael and Bill led the Canadian-based Global Business and Economic Roundtable on Mental Health and launched the US/Canada Forum on Mental Health and Productivity in Washington when Michael was Canada's Ambassador to the US. The Forum then alternated between US and Canadian cities – Ottawa, Boston (at Harvard University), Toronto twice and Denver. Michael and Bill then convened a series of CEO Summits between 2002 and 2013 that put 'mental health in the workplace' solidly on the corporate map.

 In 2013, Bill – with Michael's support - turned his attention to Europe, chairing a 4-year business-led campaign called TARGET DEPRESSION IN THE WORKPLACE and the European Business Leadership Forum for Mental Health in the Workplace. For this campaign, Canada's Ambassadors to Denmark, United Kingdom, Spain, Italy, and Belgium hosted roundtable meetings with European business leaders for Bill who travelled to more than 20 European capitals to promote the campaign, taking his message to institutions as diverse as the European Central Bank and Royal Mail and overall, to employers with one million employees in Europe. Bill ended the campaign in 2017.

ON NOVEMBER 20, 2015, McMaster University, among the top 75 universities in the world, conferred upon Bill an Honorary Doctor of Laws, its highest recognition, for his work in mental health across international borders, and appointed Bill to a 3-year term as Industry Professor of International Mental Health.

Throughout the 20 years Bill Wilkerson and Michael Wilson worked together to advance mental health and fight mental illness, both were recognized widely for their work including the Public Service of Canada. Bill was also sworn-in as the RCMP's first civilian mental health adviser. Before his mental health advocacy, Bill Wilkerson served in a wide range of chief and senior executive roles in business, broadcasting and the arts and was a crisis management and news media consultant to major corporations and major league sports including the National Hockey League.

bill.wilkerson@mentalhealthinternational.ca