

Addressing the social and financial impact of the residential mould toxicity issue. A Critical review and social call for change in the Canadian medical system towards healthy homes and happy families.

Craig Hostland P. Eng. MBA FEC CIEC

Dr. Gordon Lovegrove P. Eng. PhD

Dr. Deborah Roberts P. Eng. PhD

Addressing the social and financial impact of the residential mould toxicity issue. A Critical review and social call for change in the Canadian medical system towards healthy homes and happy families.

C. Hostland¹, G. Lovegrove², D. Roberts³

Abstract – to be completed

Key words:

1 Introduction – to be completed

2. Background: dampness, mould, and ill-health

The medical systems in North America bears a large responsibility in the non-identification of mould from damp buildings and the associated epidemic of building related ill-health in the general North American population. Critically, the present health care profession is mute on the consequential relationship between ill-health and indoor environments; as exhibited by the fact this connection is not included as a topic in medical curricula (assessing the human body independent of environment) (Wu et al, 2007).

As such, when becoming adversely health-affected, patients are progressed through the existing medical system exclusive of their home or work environment (Cabral JPS, 2010). Only when the medical systems finds no physiological connection then may the patient's living environment gain consideration; or in the case where the medical system does not question home environment conditions and a solution is not apparent medically, the patient may only then

¹ PhD graduate student Civil Engineering, School of Engineering, University of British Columbia Okanagan, Kelowna, BC Canada V1V 1V7, E-mail: craig.hostland@alumni.ubc.ca

² Assistant Professor, School of Engineering, University of British Columbia Okanagan, Kelowna, BC Canada V1V 1V7, E-mail: gord.lovegrove@ubc.ca

³ Associate Professor Associate Director: Graduate Studies and Research, , School of Engineering, University of British Columbia Okanagan, Kelowna, BC Canada V1V 1V7, E-mail: Deborah.roberts@ubc.ca

contact an indoor environment specialist for assessment assistance. Data on occupational asthma are not routinely collected as there is no specific ICD code that defines it in the hospital admissions and mortality data (PHAC 2007).

Further, people don't generally or easily make the link between their ill-health and poor household indoor air quality but do rely strongly on the medical profession for proper assessment and procedural accuracy (Hostland, 2010). Where diagnoses are made or cures considered, the home environment as a cause remains elusive to the detriment of the patient.

“The worst thing for a physician (clinician) to do is to help someone get well and then send them back into the situation that got them sick in the first place”.

Sir Michael Marmot (WHO)

In addition, many people act like they have no time for medical attention and as such do not proceed through the medical system at all, or are thwarted by waiting room line-ups and available appointment time. With or without medical treatment, the afflicted continue to function at a reduced rate and remain compromised when conducting normal functions including attempting to live pain free and work at regular jobs. Some are impacted to the point of not being able to sustain normal social functions. As well, society is adversely impacted each time the health care system is accessed or demand is elevated due to a specific causal effect, each time subsidized drugs and treatments are prescribed and each time someone loses their ambulatory abilities and health care services are called upon to assist in day-to-day required activities.

Indoor environmental impacts on occupants in homes can be defined within the context of health safety; well-being; and reaction to contamination products. Contamination can be in solid form (lead; asbestos; mould growth; dust mites; chemicals; biological growth); or aerosolized as in volatile organic compounds, noxious gases, mycotoxins (from moulds); and bacteria. The more defined 'indoor air quality' term relates to indoor air pollutants. Of these considerations, mould (aerosolized microbial growth) is the least defined and least understood, yet is only now being considered a major contributor to the significant increase in asthma, cardiovascular disease, and chronic malaise (SBS) within the general North American population.

Sick building syndrome (SBS) is a term used to describe situations in which building occupants experience acute health and comfort effects that appear to be linked to time spent in a building, but no specific illness or cause can be identified. The complaints may be localized in a particular room or zone, or may be widespread throughout the building (EPA). Recent studies of residential IAQ issues have exposed mould (considered toxic when it begins to affect health) as the prime culprit in ill-health of affected occupants (Hostland, 2010). For the purpose of this research paper; IAQ, IEQ (indoor environment quality) will be considered interchangeable.

Further, Hostland (2010) site studies and contact records show a high incidence of IAQ affected occupants occur in low income rental environments. Further, Hostland found that tenant

complaints of SBS related sickness were not positively addressed by landlords nor by the BC Residential Tenancy complaints process even when verified mould environments were professionally documented. Without options to move (low vacancy rate or lack of available funds to relocate) and no recourse through medical or government assistance programs, tenants literally remain confined to environments that make them and their children sick - to the point of exhaustion and utter despair which leads to mental health impacts (Friedl, 2009). The cycle of chronic sickness, constant trips to the emergency room and ongoing need of social support is not easily broken by a system that does not recognize the plight of our working poor and their children.

A limited number of research studies associating mould with asthma and ill-health have been conducted providing an odds ratio of 1.1 to 4.7 with a 95% probability of accuracy for this connection from 6 studies (Sahakian et al., 2008) with an incident rate ratio of .6 to 8.5 from three studies. A rate ratio in epidemiology is calculated to compare the ratio of events occurring ... Rate Ratio Incidence Rate 1/Incidence Rate 2.

3. Medical industry: Change reactive to proactive treatment of poor indoor environments

Every individual who seeks medical care through the Canadian health care system is being subsidized by public monies. Therefore reducing doctor and hospital visits, eliminating the use of prescription drugs, inhalers, and treatment services would fiscally benefit society as a whole. Addressing the source of ill-health in homes before the occupant requires healthcare will reduce this burden on the health care system. The cost benefit analysis contained in this report utilizes doctor visits, emergency room visits, and hospital bed stays to estimate the impact on the medical system. Individual and societal benefits are discussed further on in this paper.

The real cost to society for failure to proactively address and reverse the impact of poor indoor environments can be measured. This entails confirming the cost of remediating mould containing indoor environments that cause or exacerbate allergenic reactions to the extent of hospitalization or outpatient support with medications. A positive net present value of the measured reduction in future medical costs will form the basis for a significant shift in medical payouts from reactive to proactive measures as the pressure to reduce health care dollars mounts.

4. Methods for instituting change in our society – to be completed

ICBC model

Gov't Canada energy program subsidy model

ASTHMA PROGRAM

The data on emergency room visits and hospitalization suggest that asthma control is improving in the population. One critical factor in control is the appropriate use of Asthma Practice Guidelines by physicians. Another critical element for effective control is the active involvement of individuals with asthma and their families. Many asthmatics need help in utilizing management strategies such as asthma action plans. Adequate training of asthma educators, funding for asthma education and increased access to this service could improve the effective control of symptoms and the appropriate use of health services by individuals with asthma. Efforts need to continue in order to further improve asthma control in the population (PHAC 2007).

To garner a sustainable solution, within a holistic approach to designing an all encompassing program to address ill-health in homes due to mould proactively, we consider the risks and opportunities in developing and enacting preventative IAQ solutions using the sustainable value framework (graphic A) within the structure of the 5 stages of emerging drivers in appendix A (Senge, 2010). We will consider the Government of British Columbia's Ministry of Health and locally, the Interior Health Authority (IHA) as the "organizations" reacting necessarily to ballooning health care costs and seeking innovative ways to meet societal needs and garner large cost and risk reductions as a result of early investment in preventative care.

Sustaining the process of improving and then maintaining homes as clean and free of health affecting irritants required to ensure realization of the fiscal benefits of reduced health care requirements necessitates a top to bottom systems design that captures the reality of today and prepares for the requirements of tomorrow. Sustainability⁴ is an economic, social, and ecological concept. It is intended to be a means of configuring civilization and human activity so that society and its members are able to meet their needs and express their greatest potential in the present, while preserving biodiversity and natural ecosystems, and planning and acting for the ability to maintain these ideals indefinitely. Sustainability affects every level of organization, from the local neighbourhood to the entire globe. Suffice to say, whether implementing a rigorous regulatory process founded on penalties; providing incentives to upgrade mould affected homes; or co-opting the population through PR initiatives and mandated change to government delivery organizations, the momentum will quickly dissipate if a self-righting system is not in place to ensure longevity. The opportunity for an on-going cycle of needs attainment can turn into a risky endeavour without a regenerative revenue plan.

The details of this particular system design will be undertaken in a subsequent paper; but what we can use from a basic systems sustainability model for the purpose of this paper, is a simple government incentive and marketing program similar to the existing federal energy home upgrade program that has been very successful, particularly when the Province of BC was also involved. The "un-healthy home incentive program" would commence with marketing the need for specific pre-emptive indoor air quality products and upgrades in buildings (using literature

⁴ wordIQ.com

already developed by government health care programs ready to distribute), set minimum guidelines for applicability to the program (ie inadequate heating and ventilation systems; significant mould growth; doctor's verification of SBS sickness; etc), provide government (municipal/ Provincial/ Federal) funding for 5 – 15% reimbursement of accepted remediation costs (with transfer of payouts to Health Regions as the cost benefit is realized (similar to ICBC support of accident limiting projects) as a short term impetus, monitor the success of the program, and adapt/ adjust to market response conditions. Finally, complete the intent of the sustainability value matrix by adapting existing systems to incorporate renewable products and services and innovation incentives to develop needed solutions for the future.

The largest risk in undertaking this progressive initiative is that it will not provide verified cost benefits. With that would be failure of the entire program, a collapse similar to a house of cards. To temper that extreme, any cleanup of compromised homes will benefit occupants, when the environmental benefits are measurable. Considering that the existing health care financing and funding system is a mature (well ingrained) program, where every dollar is accounted for and allocated and insufficient funding purveys the landscape, allocating funds to a capital expenditure now for future gains, even only a few years out will likely garner stark rebuke from health care leaders and the reactionary media. In short, the existing system is focussed on reactionary medicine that is consigned to pay the inflated cost of post illness medical treatment. Changing this engrained mentality and well oiled administrative machinery will require a significant event or alternate event horizon. It requires a 180 degree change of thinking. Preventative health care programs not only abound, they come and go. Costly initiatives to handle inpatient demands are regular events. The fundamental flaw of not balancing this initiative with revenue returning milestones perpetuates the failure of costly initiatives and a lack of initiative for the health care industry to make directional change. This will require sound fundamental policy statements, well researched marketing, and action oriented goal making.

Interestingly, the Federal/ Provincial energy program does not appear to be a revenue neutral program. That is, tax revenues from increased business to implement improvements appear to fall short of the incentives payout. This increases the risk of failure. The recent cancellation of this program and the earlier cancellation of the Gov't of BC component, because they ran out of money for the program, and the negative impact it immediately placed on those businesses that developed to deliver the services, is reason enough to ensure this health care initiative be designed for ongoing sustainability. The risk is turned into an opportunity.

Consequently, this initiative then must be designed to be financially sustainable on its own from the onset using established means and methods that neither require design nor creation. These would include use of existing remediation equipment and procedures and environmental testing and assessment methods. Once the financial benefits kick in from the first run of projects, reduced Health region costs will be funnelled back into the program to subsidize even more health protection projects directly or through government tax incentives. Savings will be tracked and captured and returned to the program. With this alone, there appears to be more opportunity for success than with the Federal/ Provincial energy home upgrade program and political non-sustainable decision making. The risk can be quantified and monitored over the early years of implementation and modified as required through short term milestone

assessments. The payoff will be program legitimacy and a corresponding enhanced reputation for the driving forces behind the health awareness programs that would have developed from the onset. People generally see all health initiatives as a subsidized expense. This program will be defined by the monies it saves as well as the lives it saves or enhances, giving it legitimacy that will extend to the community as well as the Health Region and other Government entities closely tied to the health initiatives under the “unhealthy home program”. The opportunity is to generate a win-win scenario for the patient as well for the BC Ministry of Health and Health Region.

The Ministry of Health/ IHA will be required to reorganize inpatient information to specify home environment mould impacts to form the basis for evaluation and assessment of the impacts on the health care system and develop tracking indicators for responsiveness at points of contact with the patient. This reorganization will have to mesh with the codification already utilized by the health care system to track morbidity rates. New identification morbidity codes for residential based ill-health will coincide with the initial phase awareness program within the health care system for doctors, other health care providers, and emergency room attendants to best expose the issue of residential based environmental health impacts. Those health issues that may be deemed commercial based can be quickly passed over to Worksafe BC for further investigation of cause and solution. Identifiers for residential based ill-health should focus on flue-like symptoms that relate to asthma and only seem to occur while the patient is at home (or at their workplace) including: dry cough; cough with phlegm; in concert with shortness of breath; low grade headaches; low grade fevers; general malaise; etc. Those patients that appear to have ill-health conditions that are exacerbated only at home can become the focus of further assessment of their home environments by health care providers, municipal officials, and IAQ building investigators. Regular statistical updates will be necessary to accurately monitor the success and failure elements of the residential ill-health program.

The external aspect of this initial phase initiative is awareness based. It is an opportunity for a redefined public announcement program that simply and clearly exposes the basics of better IAQ in homes to the general public under a health care stewardship banner. The health services industry will take the central position of being the information provider to the general population that sickness is where they live and the occupant alone can reduce the incidence of sickness by undertaking simple measures in their own homes.

Following the success of the initial awareness campaign with positive feedback from the first run remediation projects that the health initiatives reduce hospital visits and stays, the next phase of the initiative of visually representing the face of health care tomorrow and on into the future will create the opportunity through success of the program to cause the health profession to begin to collaborate amongst its own (hospitals talking to walk-in clinics; doctors talking to paramedics; health care providers talking to non-governmental organizations); those who exercise an impact within the professional to strengthen lines of communication; reduce information transfer delays; and to develop the awareness of SBS exposure; its consequences; and develop and then initiate the steps to repair an unsustainable system. This phase will see the development of heightened levels of discussion and awareness that develops into far seeing initiatives with opportunity for innovative thought and innovative programs.

Once the ill-health home incentives program gathers momentum, success will drive the program towards innovation, sustainable growth, and a sustainable competence that will magnify the benefits into other areas of our society and will support other municipalities/ regions/ Governments/ countries to incorporate this systems model into their societal needs and requirements.

5. Risks and Opportunities for Proactive Treatment of Poor Indoor Environments

Every individual who seeks medical care through the Canadian health care system is being subsidized by public monies. Therefore reducing doctor and hospital visits, eliminating the use of prescription drugs, inhalers, and treatment services would fiscally benefit society as a whole. Addressing the source of ill-health in homes before the occupant requires healthcare will reduce this burden on the health care system. The cost benefit analysis contained in this report utilizes doctor visits, emergency room visits, and hospital bed stays to estimate the impact on the medical system. Individual and societal benefits are discussed further on in this paper.

The real cost to society for failure to proactively address and reverse the impact of poor indoor environments can be measured. This entails confirming the cost of remediating mould containing indoor environments that cause or exacerbate allergenic reactions to the extent of hospitalization or outpatient support with medications. A positive net present value of the measured reduction in future medical costs will form the basis for a significant shift in medical payouts from reactive to proactive measures as the pressure to reduce health care dollars mounts.

The non-financial ill-health impacts, those externalities such as impact on mental health due to emotional and physical stressors from mould induced ill-health and its corresponding impact on the health care system are yet to be measured with further study required to make the connections that appear apparent in this paper.

To garner a sustainable solution, within a holistic approach to designing an all encompassing program to address ill-health in homes due to mould proactively, we consider the risks and opportunities in developing and enacting preventative IAQ solutions using the sustainable value framework (graphic A) within the structure of the 5 stages of emerging drivers in appendix A (Senge, 2010). We will consider the Government of British Columbia's Ministry of Health and locally, the Interior Health Authority (IHA) as the "organizations" reacting necessarily to ballooning health care costs and seeking innovative ways to meet societal needs and garner large cost and risk reductions as a result of early investment in preventative care.

5.1 Opportunity: A Systems Sustainability approach

Sustaining the process of improving and then maintaining homes as clean and free of health affecting irritants required to ensure realization of the fiscal benefits of reduced health care requirements necessitates a top to bottom systems design that captures the reality of today and

prepares for the requirements of tomorrow. Sustainability⁵ is an economic, social, and ecological concept. It is intended to be a means of configuring civilization and human activity so that society and its members are able to meet their needs and express their greatest potential in the present, while preserving biodiversity and natural ecosystems, and planning and acting for the ability to maintain these ideals indefinitely. Sustainability affects every level of organization, from the local neighbourhood to the entire globe. Suffice to say, whether implementing a rigorous regulatory process founded on penalties; providing incentives to upgrade mould affected homes; or co-opting the population through PR initiatives and mandated change to government delivery organizations, the momentum will quickly dissipate if a self-righting system is not in place to ensure longevity. The opportunity for an on-going cycle of needs attainment can turn into a risky endeavour without a regenerative revenue plan.

The details of this particular system design will be undertaken in a subsequent paper; but what we can use from a basic systems sustainability model for the purpose of this paper, is a simple government incentive and marketing program similar to the existing federal energy home upgrade program that has been very successful, particularly when the Province of BC was also involved. The “un-healthy home incentive program” would commence with marketing the need for specific pre-emptive indoor air quality products and upgrades in buildings (using literature already developed by government health care programs ready to distribute), set minimum guidelines for applicability to the program (ie inadequate heating and ventilation systems; significant mould growth; doctor’s verification of SBS sickness; etc), provide government (municipal/ Provincial/ Federal) funding for 5 – 15% reimbursement of accepted remediation costs (with transfer of payouts to Health Regions as the cost benefit is realized (similar to ICBC support of accident limiting projects) as a short term impetus, monitor the success of the program, and adapt/ adjust to market response conditions. Finally, complete the intent of the sustainability value matrix by adapting existing systems to incorporate renewable products and services and innovation incentives to develop needed solutions for the future.

The largest risk in undertaking this progressive initiative is that it will not provide verified cost benefits. With that would be failure of the entire program, a collapse similar to a house of cards. To temper that extreme, any cleanup of compromised homes will benefit occupants, when the environmental benefits are measurable. Considering that the existing health care financing and funding system is a mature (well ingrained) program, where every dollar is accounted for and allocated and insufficient funding purveys the landscape, allocating funds to a capital expenditure now for future gains, even only a few years out will likely garner stark rebuke from health care leaders and the reactionary media. In short, the existing system is focussed on reactionary medicine that is consigned to pay the inflated cost of post illness medical treatment. Changing this engrained mentality and well oiled administrative machinery will require a significant event or alternate event horizon. It requires a 180 degree change of thinking. Preventative health care programs not only abound, they come and go. Costly initiatives to handle inpatient demands are regular events. The fundamental flaw of not balancing this initiative with revenue returning milestones perpetuates the failure of costly initiatives and a lack

⁵ wordIQ.com

of initiative for the health care industry to make directional change. This will require sound fundamental policy statements, well researched marketing, and action oriented goal making.

Interestingly, the Federal/ Provincial energy program does not appear to be a revenue neutral program. That is, tax revenues from increased business to implement improvements appear to fall short of the incentives payout. This increases the risk of failure. The recent cancellation of this program and the earlier cancellation of the Gov't of BC component, because they ran out of money for the program, and the negative impact it immediately placed on those businesses that developed to deliver the services, is reason enough to ensure this health care initiative be designed for ongoing sustainability. The risk is turned into an opportunity.

Consequently, this initiative then must be designed to be financially sustainable on its own from the onset using established means and methods that neither require design nor creation. These would include use of existing remediation equipment and procedures and environmental testing and assessment methods. Once the financial benefits kick in from the first run of projects, reduced Health region costs will be funnelled back into the program to subsidize even more health protection projects directly or through government tax incentives. Savings will be tracked and captured and returned to the program. With this alone, there appears to be more opportunity for success than with the Federal/ Provincial energy home upgrade program and political non-sustainable decision making. The risk can be quantified and monitored over the early years of implementation and modified as required through short term milestone assessments. The payoff will be program legitimacy and a corresponding enhanced reputation for the driving forces behind the health awareness programs that would have developed from the onset. People generally see all health initiatives as a subsidized expense. This program will be defined by the monies it saves as well as the lives it saves or enhances, giving it legitimacy that will extend to the community as well as the Health Region and other Government entities closely tied to the health initiatives under the "unhealthy home program". The opportunity is to generate a win-win scenario for the patient as well for the BC Ministry of Health and Health Region.

The Ministry of Health/ IHA will be required to reorganize inpatient information to specify home environment mould impacts to form the basis for evaluation and assessment of the impacts on the health care system and develop tracking indicators for responsiveness at points of contact with the patient. This reorganization will have to mesh with the codification already utilized by the health care system to track morbidity rates. New identification morbidity codes for residential based ill-health will coincide with the initial phase awareness program within the health care system for doctors, other health care providers, and emergency room attendants to best expose the issue of residential based environmental health impacts. Those health issues that may be deemed commercial based can be quickly passed over to Worksafe BC for further investigation of cause and solution. Identifiers for residential based ill-health should focus on flue-like symptoms that relate to asthma and only seem to occur while the patient is at home (or at their workplace) including: dry cough; cough with phlegm; in concert with shortness of breath; low grade headaches; low grade fevers; general malaise; etc. Those patients that appear to have ill-health conditions that are exacerbated only at home can become the focus of further assessment of their home environments by health care providers, municipal officials, and IAQ building

investigators. Regular statistical updates will be necessary to accurately monitor the success and failure elements of the residential ill-health program.

The external aspect of this initial phase initiative is awareness based. It is an opportunity for a redefined public announcement program that simply and clearly exposes the basics of better IAQ in homes to the general public under a health care stewardship banner. The health services industry will take the central position of being the information provider to the general population that sickness is where they live and the occupant alone can reduce the incidence of sickness by undertaking simple measures in their own homes.

Following the success of the initial awareness campaign with positive feedback from the first run remediation projects that the health initiatives reduce hospital visits and stays, the next phase of the initiative of visually representing the face of health care tomorrow and on into the future will create the opportunity through success of the program to cause the health profession to begin to collaborate amongst its own (hospitals talking to walk-in clinics; doctors talking to paramedics; health care providers talking to non-governmental organizations); those who exercise an impact within the professional to strengthen lines of communication; reduce information transfer delays; and to develop the awareness of SBS exposure; its consequences; and develop and then initiate the steps to repair an unsustainable system. This phase will see the development of heightened levels of discussion and awareness that develops into far seeing initiatives with opportunity for innovative thought and innovative programs.

Once the ill-health home incentives program gathers momentum, success will drive the program towards innovation, sustainable growth, and a sustainable competence that will magnify the benefits into other areas of our society and will support other municipalities/ regions/ Governments/ countries to incorporate this systems model into their societal needs and requirements.

Innovation and innovators will direct the development of health prevention opportunities: of more defined and refined methods to isolate SBS from asthma to focus on cures; new means and methods to isolate specific health issues from SBS to develop health care solutions; and then new means and methods within the home environment to develop opportunities to eliminate the possibility of affliction and within the healthcare field, new health treatments and diagnostics for remedy. This is discussed in more detail further on in the paper.

6. Facing the future: Innovation through Vision

Innovation using the sustainable value model as noted above will generate necessary new ideas, concepts, and actions from the medical and health services field as well as from the IAQ services industry; construction industry; Governments; and from public oversight initially from the sheer creativity of like-minded passionate change agents (innovators) and then from realized gains in efficiency oriented delivery agents (service sector and medical sector). Innovation within the medical industry will include: the development of more defined and refined methods to isolate SBS from asthma; new means and methods to isolate specific health issues from SBS;

and then new means and methods within the home environment to eliminate the possibility of affliction and within the healthcare field including new health treatments and diagnostics for remedy.

From the indoor air quality industry, more qualified professional with better measuring techniques, further research, studies, and focus on mould in damp residential environments will better define the cause, effects, and solutions to strive for. Identification costs and remediation costs for eradication of mould developed environments are steadily dropping as more skilled residential based IAQ remediators find economical solutions to achieve adequate response outcomes.

Within the construction industry, when challenged, better IAQ in homes can be accomplished using existing tools, equipment, best new procedures with a focus on stopping moisture migration and retention of moisture in the building envelope using better techniques; bettering ventilation to reduce the retention of excess moisture, combustion gases or chemicals from product off-gassing; better filtration to capture airborne particulates, pollens, and moulds; and improvement of heating and air conditioning systems that contribute to poor air circulation. The elimination of furnace and hot water pilot lights that can generate CO, CO₂, NO₂ and the elimination of VOC laden building products can be easily accomplished with existing technology along with the installation of HEPA quality air filters in forced air heating and cooling systems. Renovations that add functioning washroom and kitchen exhausts fans can be accomplished now. Repairs to the building envelope to stop moisture migration is now considered to generally be part of regular home maintenance as is the double paning of windows and moisture proofing and insulating of crawlspaces.

Available in the marketplace and also becoming recognized as having a high IAQ importance is the use of HEPA quality carpet vacuums; ultra violet (UV) light airborne debris capture used in the duct work of forced air heating and cooling systems; and portable dehumidification appliances. Non-allergenic products and furnishings are readily available. These are now consumer level produced products that are competitively priced for the environmentally sensitive. New home builders are being opportunistic by incorporating these new IAQ based products and services right into their construction although at this point in time at premium pricing. Many web based services (ie CMHC.ca; EPA.com; healthhouse.org; etc.) are providing easily accessible ideas and concepts to builders and home buyers alike. The tenets of mass production assure that premium pricing for innovative products will reduce to zero impact over time.

Private industry product development in the near future will bring the cost of non-mould capture building materials such as paperless drywall and non-mould forming non VOC insulations down enough to ensure direct application into the standard construction process. New and innovative building products (limestone based) that actually absorb air pollution and release oxygen are being touted as an answer to poor IAQ in built structures.

It is not abnormal to consider government as a provider of resources, capital, or financial underwriting to worthy health initiatives.

“Many would be surprised to learn that the greatest contribution to the health of the nation over the past 150 years was made, not by doctors or hospitals, but by local government.”

Dr. Jessie Parfitt, in *The Health of a City: Oxford* Public Health Physician

Governmental involvement on the municipal policy and bylaw level will follow as public awareness on the extent of impact mould in homes has on the health care system becomes known. Cost-benefit supported tax incentives will focus homeowners, public and private building owners and developers on the remediation of suspect indoor environments just as the recent eco-energy grants program successfully focused the public on investing in the energy efficiency of their homes even though rebates were small and documented fiscal paybacks were not confirmed.

Once made aware, the general public will increasingly demand (Senge’s 5 stages of emerging drivers stage 3 – beyond compliance) that damp mould affected homes be remediated for the overall benefit to society. The public will begin to expect that toxic mould environments be identified and addressed prior to the development of ill-health in occupants and that those affected homeowners be made responsible for the cost of remedy (where able).

For example, existing municipal bylaws identify, track, and provide oversight on the proper remediation of marijuana grow operations through a simple yet effective policy. What were toxic environments handed down from owner to usually unsuspecting owner with corresponding home related sickness from toxic mould ingestion are now homes that meet indoor air quality parameters for safe and healthy occupancy. This is a model for the remediation of broader environmental conditions in many homes as it is for verified toxic mould in homes based on a tenant complaints process. The infrastructure is already in place. Policies and bylaws can be written in BC as they are written in other jurisdictions. The Government of Alberta now has tenancy laws that allow officials to confirm IAQ issues in rental units with the authority to ensure remedy. Understanding and drawing on how that process is working will help a “made in BC” solution be successful.

This phase of innovation should be designed to ensure full concept capture and action by the general population such that particular environments that lead to poor IAQ are pre-emptively eliminated altogether. For example, an Okanagan 1970’s style home or apartment building tends to be electrically heated, with single pane windows, with no mechanical ventilation or air filtration building design suffers from damp environments and mould growth (Hostland, 2010) The payoff is sustainable growth in the health and well-being of our general population, but more particularly, that part of our population that constitutes a large burden on our society. By reducing the population of health affected patients, society overall benefits in addition to those who otherwise might have been constant users of the health care system.

Conclusions from this study may help to further initiatives that ensure the general population is protected from unhealthy building environments and as a result, society will not be further weighed down by skyrocketing health care costs pertaining to toxic mould into the future. This

research paper exposes a great need for more quantitative information so that the cost effectiveness of measures that improve indoor air quality can be calculated.

Our belief is that innovations will be made in specificity of ailment towards disease prevention; reduction in moisture capturing materials and reduction in off-gassing materials; simpler fresh air ventilation and natural heating systems that take into account natural convective, conductive and radiation currents; innovations in measuring and reactive “smart” devices that assess and correct the environment to minimize mould and mycotoxin production; smart systems that advise out of balance living environments and provide prudent economical recommended solutions and suggested remedial timelines. We believe an in-tune health care system will use their immense communicative skills to help correct occupant living errors through clear, concise natural prescriptions for life balance; reduction of reactive medicine and implementation of proactive medical treatments as normal course. We believe the next twenty to forty years will be the most productive in moving the general population from reactive degenerative mannerisms to proactive socially conscience mindsets.

7. Concluding Remarks

Externalities that may provide additional benefits include reduced financial liability, reduced medical plan payouts with corresponding reduced premiums, increased client base from improved marketability, and reduced employee turnover rates “may add significantly to the overall economic benefits” (Syal. 2009. P. 23). This conclusion is in keeping with the research noted above. Given the naturally wide ranging results based on unknowns, specific site circumstances, typical variability of management teams, the variability of macro- economics, and the human factor, we believe increased early investment in IAQ based residential initiatives to gain financial benefit from future impact reductions, that fiscal projections should be well on the conservative side and have a high probability of success prior to commencement of any venture of this nature, particularly given that those in engrained existing systems will find ways to reduce the positive effects and negatively respond to perceived gains. We believe that any financial gains over and above the recouping of sunk costs would be a bonus beyond the truly foundational gains in occupant well-being that result in reduced illness days and higher personal productivity.

Acknowledgements

We would like to acknowledge the University of British Columbia graduate program for its support and research recommendations. The Government of Alberta Health Services department and Interior Health of the Okanagan region were very helpful in directing inquiries to the proper offices for statistics used in this paper.

Limitations

A thorough review of literature found the scientific extension of the subject matter sparse and somewhat limited. Motivation for research came from personal experience in the IAQ residential field over the past 8 years that exposed a lack of science based facts and limited research. The literature search as well as personal experience in the form of networking and professional communication provided the basis for determining the present IAQ residential conditions and issues.

Economic results as well as medical based results are also drawn from commercial building and multi-family environments and inner-city studies with study results assumed to be consistent with single family dwelling environments. Further study is necessary to prove the accuracy of this assumption.

References

- Bernstein, J. A., Levin, L., Crandall, M. S., Perez, A., & Lanphear, B. (2005). A pilot study to investigate the effects of combined dehumidification and HEPA filtration on dew point and airborne mold spore counts in day care centers. *Indoor Air*, 15(6), 402-407.
- Bush, R. K., Portnoy, J. M., Saxon, A., Terr, A. I., & Wood, R. A. (2006). The medical effects of mold exposure. *Journal of Allergy and Clinical Immunology*, 117(2), 326-333.
doi:10.1016/j.jaci.2005.12.001 ER
- Cabral, Joao PS (2010) *Science of the Total Environment*, 408, 20, 4285-4295
- CDC (2002) Surveillance for Asthma – United States, 1980 –1999 MMWR march 2002 /51 (ss01): 1-13
- Chau, C. K., Tse, M. S., & Chung, K. Y. (2010). A choice experiment to estimate the effect of green experience on preferences and willingness-to-pay for green building attributes. *Building and Environment*, 45(11), 2553-2561.
- Daisey JM. Et al. (2003) Indoor air quality, ventilation, and health symptoms in schools: an analysis of existing information, *Indoor Air* 13:53-64
- Dales et al. (1991) Respiratory Health Effects of Homes Dampness and Molds among Canadian Children. *Amer Journal of Epidemiology* vol 134, No. 2: 196-203
- Dales et al. (1997) Indoor air quality and health: validity and determinants of reported home dampness and moulds. *Int. J. Epidemiology*. 1997;26:120-5
- Engvall, K. et al. (2001) Asthma symptoms in relation to building dampness and odour in older multifamily homes in Stockholm. *Int. J. Tuberc. Lang. Dis.*, 5. 468-477.
- Fisk, W. J., Lei-Gomez, Q., & Mendell, M. J. (2007). Meta-analyses of the associations of respiratory health effects with dampness and mold in homes. *Indoor Air*, 17(4), 284-296.
- Fisk WJ et al. (2010) *Environmental Health* Association of residential dampness and mold with respiratory tract infections and bronchitis: a meta-analysis 9:72 doi:10.1186/1476-069x-9-72
- Friedl, DR. Lynne (2009) Mental health, resiliency and inequalities WHO Europe
- Hardin B.D., et al. (2002) Adverse Human Health Effects Associated with Molds in Indoor Environment. ACOEM www.acoem.org/guidelines.aspx?id=850#

- Health Canada. 2007. Residential indoor air quality guidelines: Moulds. Ottawa: Health Canada. HC Pub.:4075E. ISBN: 978-0-662-45739-8
- Holcomb, L. C., & Pedelty, J. F. (1994). Comparison of employee upper respiratory absenteeism costs with costs associated with improved ventilation. *Proceedings of the ASHRAE Annual Meeting, June 25, 1994 - June 29, , 100(2)* 914-921.
- Hope, A.P., Simon R.A., (2007). Excess dampness and mold growth in homes: an evidence based review of aeroirritant effect and its potential causes. *Allergy Asthma Proc.* 28:257-8.
- Hostland (2010) IAQ studies of 500 residences in Okanagan (2000-2010)
- Howden-Chapman, P., Saville-Smith, K., Crane, J., & Wilson, N. (2005). Risk factors for mold in housing: A national survey. *Indoor Air, 15(6)*, 469-476.
- Howden-Chapman et al. (2007) *BMJ* Effect of insulating existing houses on health inequality: cluster randomized study in the community. 2007 334:460- doi: 10.1136/bmj.39070.573032.80
- Institute of Medicine (IOM) (2004) Damp Indoor Spaces and Health Washington DC.: National Academies Press; 2004
- Jaakkola et al. (2002) *Env Health Pers* Indoor dampness and molds and development of adult onset asthma v.110(5): 543-547.
- Johnson, R., Schmid, J., & Seifert, R. (2002). Assessment of indoor air quality in interior alaskan homes. *Journal of Cold Regions Engineering, 16(4)*, 218-229.
- Kats, G. (2003). The costs and financial benefits of green buildings. A report to California's sustainable building task force. www.cape.com/ewebeditpro/items/O59F3259.pdf
- Kercsmar et al. (2006) Reduction in Asthma Morbidity in Children as a result of Home Remediation Aimed at Moisture Sources. *Environmental Health Perspectives* vol 114.8 p 1574 - 1580
- Koskinen OM et al. (1999): Adverse health effects in children associated with moisture and mold observations in houses. *International Journal of Environmental Health Research* 1999, 9: 143-156
- Koskinen OM et al. (1999):The Relationship between moisture or mould observations in houses and the state of the health of their occupants. *Eur. Respir. J.*, 14. 1363-1367.
- Kosonen, R., & Tan, F. (2004). The effect of perceived indoor air quality on productivity loss. *Energy and Buildings, 36(10)*, 981-986.

- Langdon, D. (2004). Examining the cost of green.
www.usgbc.org/Docs/Resources/Cost_of_Green_Short.pdf
- Langdon, D. (2007). Cost of green revisited- Reexamining the feasibility and cost impact of sustainable design in light of increased market adoption.
- Mendell, M.J. et al. (2002) Improving the health of workers in indoor environments : priority research needs for a natl occupational research agenda. *Am. J. Public Health.* 92.1430-1440/
- Mudarri, D., & Fisk, W. J. (2007). Public health and economic impact of dampness and mold. *Indoor Air*, 17(3), 226-235.
- Nafstad, P., et al. (1998) Residential dampness problems and symptoms and signs of bronchial obstruction in young Norwegian children. *Am. J. Respir. Crit. Care Med.*, 157. 410-414
- New York City Department of Health and Mental Hygiene. 2008. Guidelines on assessment and remediation of fungi in indoor environments. www.nyc.gov/html/doh/html/epi/mold.shtml
- Park, J., Schleiff, P. L., Attfield, M. D., Cox-Ganser, J., & Kreiss, K. (2004). Building-related respiratory symptoms can be predicted with semi-quantitative indices of exposure to dampness and mold. *Indoor Air*, 14(6), 425-433.
- Perry T et al. (2003) The prevalence of rat allergen in inner city homes and relationship to sensitization and asthma morbidity. *J. Allergy Clin Immunol* 112:346-352
- Public Health Agency of Canada [PHAC] (2007) Respiratory Disease in Canada Report *Life and Breath (2007)* Cat.: HP35-8/2007E-PDF ISBN: 978-0-662-47060-1
- Reis, R. et al. (2006). The economic Benefits of Green Buildings- A comprehensive Case Study. *The Engineering Economist*, 51:259-295
- Romm, J.J., and Browning, W.D. (1994). Green the Building and the Bottom Line- Increasing Productivity Through Energy Efficient Design. Rocky Mountain Institute.
www.greenbiz.com/files/document/O16F8527.pdf
- Rosenstreich DL et al. (1997) The role of cockroach allergy and exposure to cockroach allergen in causing morbidity among inner-city children with asthma. *N. Engl. J. Med.* 336:1356-1363
- Sahakian et al. (2008) *Immuno Allergy Clin NA* vol 28 issue 3 (august 2008)
- Sahakian, N., Park, J., & Cox-Ganser, J. (2009). Respiratory morbidity and medical visits assoc'd with dampness and air-conditioning in offices and homes. *Indoor Air*, 19(1), 58-67.

- Samet et al. (2003) *Am J Public Health Indoor Environments and Health: Moving into the 21st Century*. vol 93, no.9
- SBW (2003). SBW Consulting Inc. Achieving Silver LEED : Preliminary Benefit-Cost Analysis for Two City of Seattle Facilities. Report submitted to Seattle Office of Sustainability and Environment. Summary available at http://envirovaluation.org/index.php/2005/04/30/seattle_office_of_sustainability_and_env (dec 25, 2008).
- Senge, Peter et al. 2010 *The Necessary Revolution, Working Together to Create a Sustainable World*, Broadway books New York ISBN 978-0-385-51904-5
- Seppanen, O., & Fisk, W. J. (2005). A model to estimate the cost-effectiveness of improving office work through indoor environmental control. *American Society of Heating, Refrigerating and Air-Conditioning Engineers, ASHRAE 2005 Annual Meeting, June 25, 2005 - June 29, , 111 PART 2* 663-672.
- Seuri, M., Husman, K., Kinnunen, H., Reiman, M., Kreuz, R., Kuronen, P., Lehtomäki, K., & Paananen, M. (2000). An outbreak of respiratory diseases among workers at a water-damaged building--a case report. *Indoor Air, 10*(3), 138-145.
- Singh, A., Syal et al. (2009) Life cycle cost analysis of occupant well-being and productivity in LEED offices Michigan State University May 2009
- Singh J., Yu, CWF, Kim, J. (2010) Building pathology, Investigation of Sick Buildings – Toxic Mould. *Indoor and Built Environment* 2010;19;1:40-47
- Spetic, W., Kozak, R., & Cohen, D. (2005). Willingness to pay and preferences for healthy home attributes in Canada. *Forest Products Journal, 55*(10), 19-24.
- Tuomainen, M., Tuomainen, A., Liesivuori, J., & Pasanen, A. (2003). The 3-year follow-up study in a block of flats - experiences in the use of the finnish indoor climate classification. *Indoor Air, 13*(2), 136-147.
- Verhoeff, Burge (1997) *Annals of allergy, asthma, & Immunology* Health risk assessment of fungi in home environments vol 78:544-56
- Wendt, R., Aglan, H., Livengood, S., Khan, M., Ibrahim, E., Heidenreich, M., Aglan, H. A., Leroy, J., & Wellford, B. W. (2004). Indoor air quality of an energy-efficient, healthy house with mechanically induced fresh air. *Technical and Symposium Papers - 2004 Annual Meeting of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, June 26, 2004 - June 30, , 110 PART II* 77-84.

World Health Organization Regional Office for Europe: WHO guidelines for Indoor Air Quality: Dampness and Mould. In: WHO *Guidelines for Indoor Air Quality* Bonn, Germany; 2009: http://www.euro.who.int/_data/assets/pdf_file/0017/43325/E92645.pdf

Wu, Jacobs, Mitchell, Miller, and Karol (2007): *Environmental Health Perspectives* Improving Indoor Environmental Quality for Public Health vol 115 #6 June 2007 p 956

Zock, J. et al. (2002) Housing characteristics, reported mold exposure, and asthma in the European Community Respiratory Health Survey. *J. Allergy Clin. Immunol.*, 110. 285-292

Zureik M et al. (2002) Sensitization to airborne moulds and severity of asthma: cross sectional study from European Community respiratory health survey. *BMJ* 325:411-419

Figure and Table Legend

Table 2-1: Supporting literature review studies and research

Table 3-1: Epidemiologic studies investigating an association between indoor dampness or mold and new-onset asthma or new-onset asthma-like symptoms that use odds ratios as a measure of risk

Table 3-2: Epidemiological studies investigating an association between indoor dampness or mold and new-onset asthma that use incidence rate ratio as a measure of risk

Table 5-1: Key Commercial Research findings (USA)

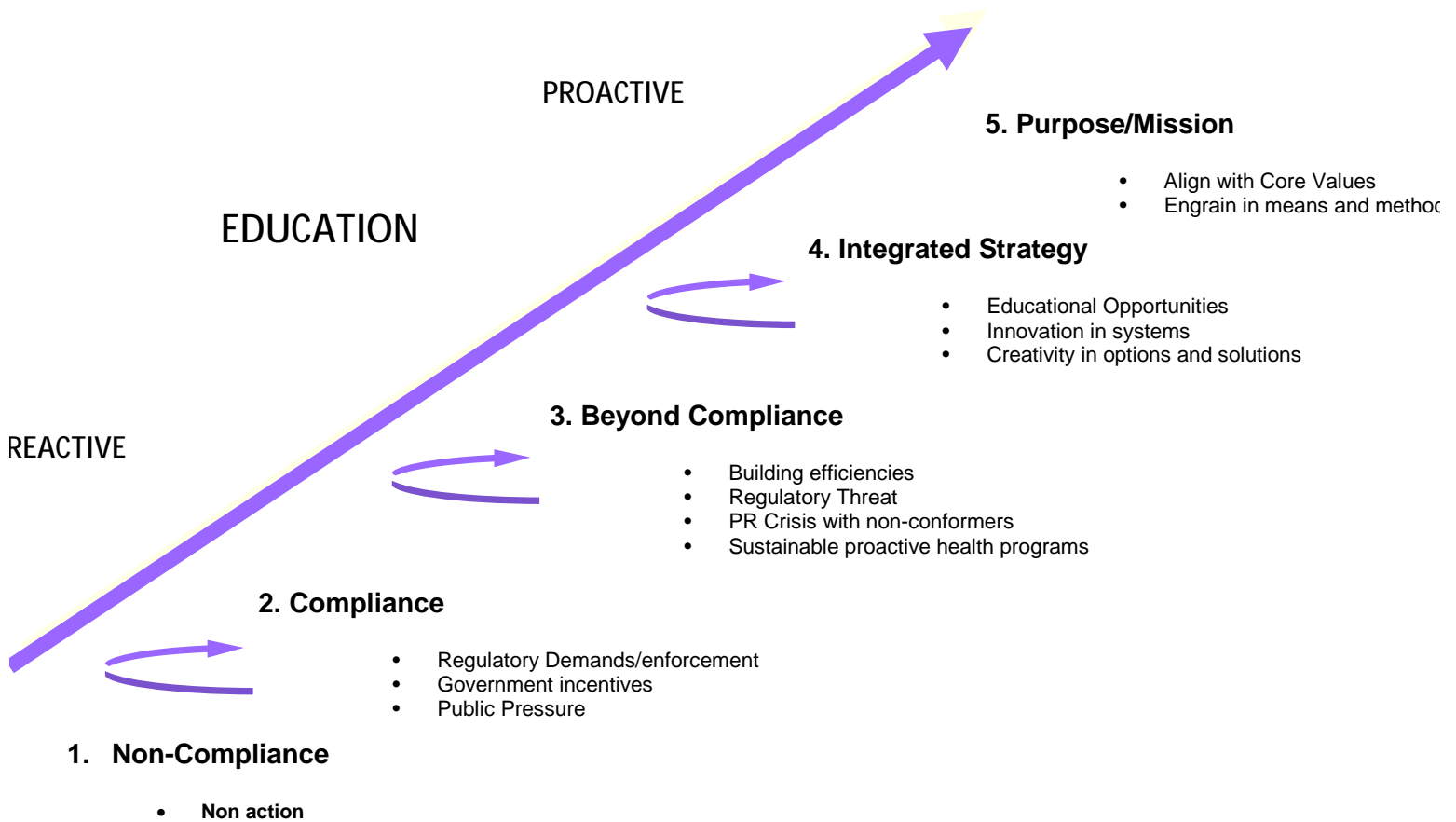
APPENDIX A

Figure A-1

The necessary revolution – a future awaiting our choices

From Compliance to Innovation –

Senge's five stages of emerging drivers (forces)



Senge's five stages of emerging drivers is an illustrative way of exposing the key concepts for taking this hidden health problem and moving it towards becoming engrained in the psyche of the general population.

Compliance – identifying the problem and considering the alternatives. The problem is not clear to the medical system, but is clear to the health affected population and on site health care professionals and service providers that health adverse home and office environments are making people sick. Worksafe BC is tasked with ensuring business environments meet exacting health and safety standards. Not so in residential dwellings. Interior health, Financial/ regulatory stakeholders (MSP, medical system, BC Health Ministry) must be made aware of the endemic problems at hand by not being actively involved in disease prevention in homes; then to set standards; and then to regulate those standards for compliance purposes.

From compliance to innovation, from reactive to proactive – as the health care system begins to meet people's home health care needs, the process begins to shift from a reactive to a proactive approach taking. The system begins to think and act beyond compliance towards innovation. With the health care Ministry sitting down with residential environmental consultants, government regulators (worksafe BC), and those afflicted, brain storming means and methods to develop a better system to proactively identify and treat home environment health concerns and issues, innovations in identification, delivery, and building environment repair and modification is sure to follow. This study will consider the type of innovations in systems, thinking, and modelling that is necessary to move the residential health care process towards an integrated societal strategy that becomes sustainable.

A comparative model is British Columbia's car insurance company, ICBC, who, in a novel way, identifies significant crash sites, determines cost effective solutions, and pays to implement the solutions to reduce costly impacts which not only benefits ICBC's fiscal bottom line, but society's "bottom line" as well. BC's Ministry of Health Care the Okanagan's Interior Health underpin health care services. Perhaps the ICBC model could be considered as an implementation tool for undertaking proactive measures to solve indoor environment problems before the health affected begin to require medical services.

This is an example of collaborating across boundaries to benefit all parties. The sustainable approach to this IAQ initiative and the application of a cost benefit component to the model may contribute new insight into government based tax incentive type initiatives thereby changing to long term sustainable programs that both benefit society as well as benefit the immediate stakeholders – home owners and their health region.

As well, innovation will come in the form of new ideas for health protection in homes; it will also come in the form of finding economical and sustainable ways to correct errors of the

past. Aware people, families, communities, will decide to choose natural products; keep chemicals out of their homes; consider the good of the community as well as their own benefits. This will lead into a period of innovation in how we address industry and our requirements for a sustainable world. Through the care of people by taking pre-emptive steps to ensure that they have a healthy home environment which now matches that of commercial properties, a wave of sustainable initiatives will evolve the fossil fuel driven economy into a green focused holistic world view. Mission and vision statements will evolve towards green initiatives.