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At the source: the origins of the Massachusetts toxics use reduction program and an overview of this special issue

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ABSTRACT

This special edition of the Journal of Cleaner Production celebrates the twentieth anniversary of a piece of legislation that has special significance to the environmental movement – the Massachusetts Toxics Use Reduction Act of 1989 (TURA). Most of the papers in this issue were presented at a symposium to commemorate the twentieth anniversary that was held on November 4, 2009.

Much has been written about the Massachusetts Toxics Use Reduction Program. It has been heralded as a major pollution prevention success story. It has been lauded as a premier American example of the precautionary principle in action. It has been condemned by the American chemical industry trade association as "bad for the chemical industry". And it has been praised by the Ford Foundation and Harvard's Kennedy School of Government as an award-receiving example of innovation in government (Harvard Kennedy School, 2005).

Looking back now to some twenty years ago—back to the early origins of the program concept—it can be seen both as a landmark breakthrough in international chemicals policy, and as a fairly conventional next step in the political evolution of Massachusetts environmental policy.

Where did this idea come from? How did it develop? How were pieces put together? Why did Massachusetts adopt such an idea into law? And how did the idea change during the early years of implementation? This paper provides a brief history of the development of the concept of toxics use reduction and the process by which it was drafted into law in Massachusetts, followed by an introduction to the articles included in this special edition and their assessment of TURA – past, present, and future.

1. Introduction

This special edition of the Journal of Cleaner Production celebrates the twentieth anniversary of a piece of legislation that has special significance to the environmental movement – the Massachusetts Toxics Use Reduction Act of 1989 (TURA). Most of the papers in this issue were presented at a symposium to commemorate the twentieth anniversary that was held on November 4, 2009.

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2. State chemical policy making

The 1980s were an active period for environmental advocacy in Massachusetts. Following the revelation of chemical contamination

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in the drinking water at Woburn in 1979, a series of alarming investigations by town officials closed drinking water supplies in some forty communities across Massachusetts. Poorly managed and abandoned hazardous waste sites were appearing throughout the Commonwealth in communities such as Lowell, Acton, Tyngsborough, Braintree, New Bedford and Mashpee (MDEQE, 1981). The official state response to these rising concerns was a major push for the siting of a hazardous waste treatment facility to treat these wastes (Langner, 1980).

However, siting such a facility proved difficult because of public concern about the dangers of hazardous waste treatment. In 1980, a new state law established an innovative process for bringing waste plant developers and town officials together to negotiate terms for siting such facilities (Provost, 1982). However, the process only further excited the popular resistance to such facilities and led to the building of a statewide network of community activists dedicated to blocking the development of hazard waste treatment facilities in Massachusetts (Ackerman, 1983).

Occupational chemical exposure was on the agenda as well. A campaign by a broad coalition of trade unions emerged in 1982 to press for enactment of a workplace "right to know" statute to provide workers with information about the chemical hazards they were exposed to at work. In order to broaden the coalition to include community activists, the Massachusetts AFL-CIO's so-called "Solidarity Coalition" added a community right to know provision to the bill as well (Dumanoski, 1983) and, in 1983, the bill was passed into law in the form of the Massachusetts Right to Know Act. Only a few months after passage of the Massachusetts Right to Know law, the federal Occupational Safety and Health Administration (OSHA) Hazard Communication Standard pre-empted the private sector portions of the statute (MEOLWD, 2010). Nonetheless, the Solidarity Coalition left in place a seasoned institutional structure that was capable of passing legislation.

2.1. Conceiving of toxics use reduction

Context and motivation are important to social innovation. It takes a promising situation with the right players in the right place, and it takes a clear problem in need of a good solution. However, without leadership—both individual leadership and organizational capacity—good opportunities can evaporate. The mid 1980s spawned a collection of exceptionally talented environmental leaders, many of them based in Massachusetts. Activists combined the local base of the citizen action movement's Massachusetts Fair Share with the national resources of Clean Water Action to form the National Toxics Campaign (Sirianni and Friedland, 2001). Trade union activists at the Massachusetts Coalition for Occupational Safety and Health (MassCOSH) and environmental activists at the college campus-based Massachusetts Public Interest Research Group (MassPIRG) began to expand their organizations' advocacy into occupational and environmental health protection. Meanwhile, in the public sector, officials at the Massachusetts Executive Office of Environmental Affairs and the Department of Environmental Protection were promoting source reduction and pollution prevention initiatives in their agencies.

The Massachusetts environmental advocates had a vision. They believed that people could be mobilized around health concerns in their local communities and out of those local communities a multi-class movement could be built focused on hazardous waste clean-up that could become a real force for social change. They sought a strategy that would move the old Solidarity Coalition from "right to know" to "right to act". Knowledge about toxic chemicals was not enough. People needed a program to reduce or eliminate the toxic chemicals they were exposed to.

The advocates were joined by faculty from the universities and together they saw that a focus on eliminating the toxic chemicals used in production would reduce the generation of hazardous waste, and, thereby eliminate the need for a hazardous waste treatment facility. The term "toxics use reduction" conceptualized the idea well and the advocates began building a strong argument for it.

It soon became apparent that only MassPIRG had the necessary political muscle to build a statewide legislative campaign. MassPIRG had credibility in the legislature and a statewide canvassing operation that could mobilize a grass roots base. In 1986, MassPIRG had bypassed the legislature and organized a highly successful ballot initiative campaign that set timetables and standards for the clean-up of hazardous waste sites. Their leadership decided to turn the TUR concept into a campaign for new legislation.

The last player needed was a legislature leader. Here, MassPIRG turned to Geoff Beckwith, a freshman representative who represented a middle-income Boston suburb. Beckwith joined with MassPIRG and together they converted the TUR concept into a bill.

2.2. The campaign to enact a law

The TUR bill was first introduced into the legislature by Beckwith in 1987. Beckwith moved the bill to a House hearing, but, even with the MassPIRG endorsement, it never made it out of committee. MassPIRG broadened the coalition for a second try in 1988. This was a rewritten bill more carefully structured by Beckwith, but full of small add-on sections designed to build the coalition. A worker sign-off had been added to address the concerns of MassCOSH and the trade unions. A state authority to ban hazardous chemical use had been added to be consistent with the National Toxics Campaign. A section on facility planning and a university-based research center, were inserted and MassPIRG added a section on annual chemical use reporting.

The 1988 legislative session proved more conducive and the new bill made it through a vote in the House, but now there was strong business opposition and the bill died for lack of Senate attention. However, defeat proved propitious. By now the bill was being taken seriously by the state's leadership. Recognizing the threat of the TUR bill's passage, the new director of the Associated Industries of Massachusetts (AIM) decided to adopt a more positive strategy. Over the fall, AIM wrote its own "Hazardous Materials and Waste Elimination" bill to advocate as an alternative to the TUR bill. The AIM bill included waste reduction incentives, a state technical assistance office and state authority to site a hazardous waste treatment facility. The state environmental agencies were now mobilizing and offering new ideas on implementation. In addition, MassPIRG was not quiet about the possibility of a new ballot initiative campaign on toxics use reduction.

The Speaker of the House, decided to move toward a resolution. He asked Beckwith to sit down and negotiate with AIM and the business community and come up with a consensus bill, which he would advocate for passage. Beckwith took up the challenge.

2.3. Negotiation and further negotiation

Beckwith and MassPIRG drew up a proposal for the negotiations. There would be two sides made up of an equal number of representatives and each group would be accountable to a broader range of stakeholder organizations. They would meet to consider both the TUR bill and AIM's waste elimination bill. They would convene at the beginning of 1989 and negotiate until the summer. The state agencies could sit in on the negotiations as observers and offer technical and implementation advice.

Meanwhile, Beckwith developed a proposal to site the research center, now called the Toxics Use Reduction Institute, at the University of Lowell. Finally, negotiations began in earnest in January 1989. Beckwith chose five stakeholders—three from MassPIRG and two from universities. AIM selected a respected business attorney to lead five members of the business community, including representatives from Polaroid, Digital Equipment and Exxon, as well as two private consultants.

The first meeting that commenced on a snowy day in Boston laid out the rules of the negotiation, the boundaries of the subject, and the schedule. The group then began to meet, at first bi-weekly, and, then, weekly. Several of the easy issues were resolved in the first weeks. For instance, everyone agreed that there should be a state technical assistance branch modeled on the existing Safe Waste Management Office, a university research center providing research and education, an overall administrative coordinating council, and a science advisory board to address the scientific issues.

However, the more difficult issues took many more meetings to address. The business advocates pressed for authority to site a waste treatment facility; the environmental advocates pushed for state authority to ban chemicals. Disagreements arose over chemical volume reporting thresholds, the definition of toxics use reduction, the list of regulated chemicals, the industrial sectors to be included, and the size of firms to be covered by the requirements. The list of chemicals to be included in the bill was highly contentious; the business team proposed that it be limited to the approximately three hundred chemicals regulated by OSHA, while MassPIRG proposed that it include all chemicals listed under the federal Toxics Release Inventory and the Comprehensive Environmental Response, Compensation and Liability Act. MassPIRG advocated for annual facility-level chemical use reporting, while AIM sought annual facility-level waste generation reporting (although the federal Toxics Release Inventory already required such chemical release reporting).

A very contentious issue was the ability of the state to ban or restrict the use of specific chemicals, which was strongly pushed by the environmental advocates and just as strongly opposed by the business team, who claimed that this would have the effect of driving companies out of the state. This impasse was broken by agreeing that companies be required to perform a comprehensive review of their production processes using regulated chemicals; Geiser was convinced that this planning process would lead to the identification of production changes that made sense technically and economically. Mandatory facility planning was agreed to, but it was agreed that implementation of the plan would be voluntary. The concept of plan certification by a professional "planner" was accepted, but whether this was an independent, specially trained and licensed individual or a specially designated employee of the firm was hotly debated. (Both options were included in the final text.) The parties agreed to the inclusion of a special program for priority chemical user segments, but there was much disagreement over its scale and authority.

Most contentious was the fee firms would need to pay to raise revenue for administering the program. Based on the scope of the work to be performed by the state agencies under the negotiated law, it was decided that the program would need some $4.5 to $5 million annually to cover the technical assistance, university center and regulatory responsibilities. However, there was considerable debate over how many firms would be covered and thus how much each would pay. If, as the business community argued, thousands of firms were covered by the law (they estimated 2500), then the individual firm fees could be small. If, on the other hand, the number of firms turned out to be significantly smaller (the counter estimate was some 600), then the individual fees would need to be larger. The debate was settled by authorizing a statewide survey of firms and authorizing a one-time fee adjustment to match the fee structure to the desired revenue and the empirically-derived number of firms.

As the summer approached the negotiations got hotter and the weekly negotiating sessions became even more frequent. The final session lasted nearly 24 h, ours but, bleary-eyed and drained, the two sides did ultimately reach consensus bill language.

The final bill contained compromise language on many important points, including chemical reporting thresholds, chemical lists, facility sizes, and definitions of who would qualify as a Toxics Use Reduction Planner (Fig. 1).

3. The early years of the toxics use reduction program

In July of 1989, the legislature passed the Massachusetts Toxics Use Reduction Act by a unanimous vote and the Governor, signed it into law. It was a momentous day and advocates from both sides congratulated themselves on a law that they all hoped would rise to their own somewhat chastened objectives.

During the fall, work began on implementing the new law and establishing the new TURA Program. At the state level, the older Office of Safe Waste Management was reformed into the Office of Technical Assistance (OTA) and at the Department of Environmental Protection, the commissioner appointed several agency professionals to begin regulation development. The Governor appointed an advisory committee and the Toxics Use Reduction Institute was set up at what would soon become the University of Massachusetts Lowell.

Meanwhile, events soon tested the fragile relations that supported the law's consensus history. MassDEP issued a contract for a statewide survey of all firms reporting corporate taxes in the industrial classifications included in the law, to determine which and how many firms were covered under the statutory language. The survey, which covered some 60,000 entities, revealed that the actual number of firms responsible for reporting under the TUR law was closer to 600, contrasting with the business community's estimate of 2500. AIM held to its negotiated agreement and raised no resistance to a fairly significant one-time fee increase for those firms subject to TURA requirements.

By 1990, the DEP was holding hearings on proposed regulations and sending out fee invoices. Technical assistance and training professions were hired at OTA, staff were recruited for the Institute, and a Science Advisory Board was appointed to offer scientific advice on the chemical list. The Massachusetts TURA Program was launched and running.

4. A brief review of the accomplishments of the Massachusetts toxics use reduction program

The reporting data and many program evaluations show that the TUR Act has been a success. Several of the papers in this special edition highlight some aspects of that success, ranging from improved worker health to the widespread adaption of safer solvent substitutes to toxics use reduction in communities and homes. In hindsight, it can easily be seen that the success of this internationally regarded program was strongly influenced by its unique history, period and context. In the years following Oregon (ODEQ, 2010) and New Jersey (NJTAP, 2001) passed similar legislation and several others attempted to do so. However, no other state put forward such a well funded program that contained all of the essential elements of TURA. This was not for lack of effort. Shortly after passage of the Massachusetts Toxics Use Reduction Act, the national chemical industry trade association set out a serious campaign to assure that no other state would pass similar legislation.

It would be misleading to not recognize the unique historical conditions at the time of the law's passage. There was a heady mix of

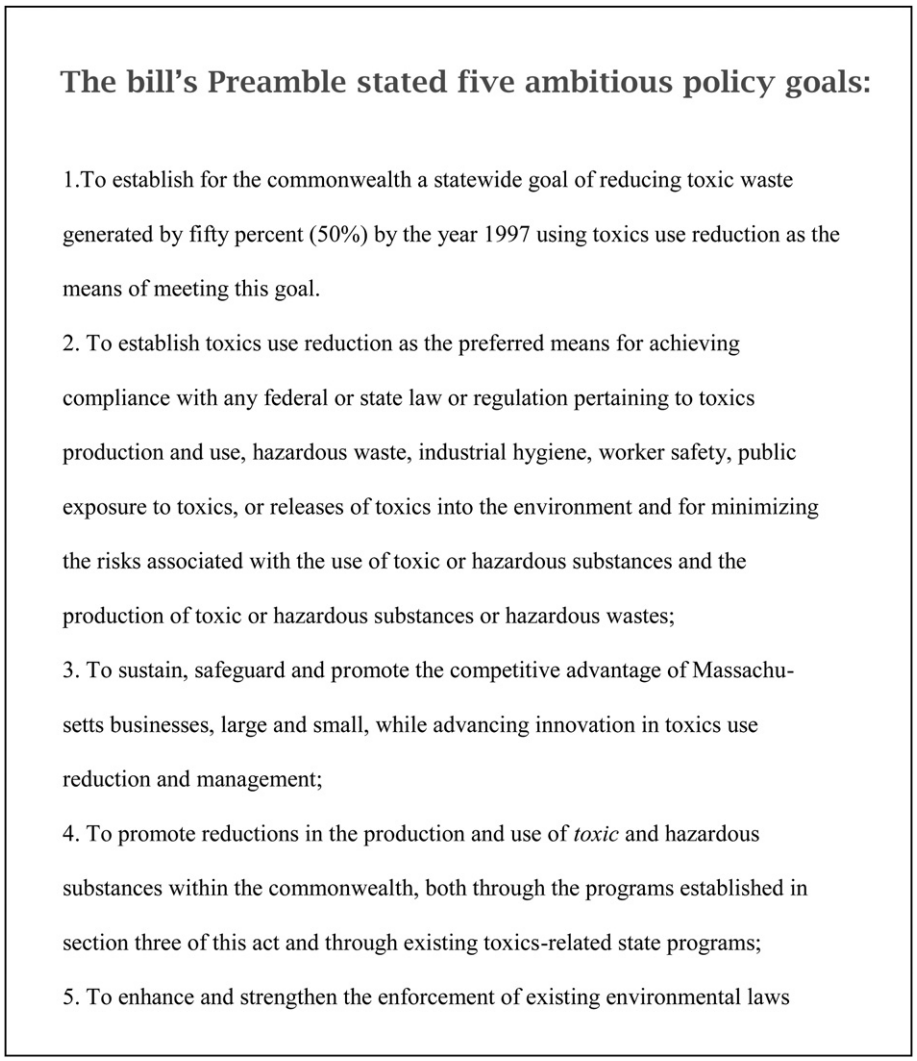

Fig. 1. The policy goals of the Massachusetts Toxics Use reduction Act.

young and talented environmental and public health advocates. The public was highly sensitive to environmental issues such as hazardous wastes and workplace chemical exposures. There was a reasonably active labor community, and the state business trade association was under the management of a fairly enlightened leadership. When the bill was first drafted the Massachusetts economy was booming, the state budget was relatively flush and the legislature was under the firm control of strong leaders with no serious opposition party. However, as the legislative process evolved much of this changed as the economy spiraled into recession and various corruption cases reverberated across the legislature.

The bill was not enacted easily. It had a long gestation period before it became a serious candidate for passage and, even then, it had a heavily negotiated development period at the hands of both the business community and the health and environmental advocates. This long development period greatly improved the bill and the fact that it was a consensus bill that was unanimously enacted offered it a long, comfortable honeymoon.

Money mattered as well. The state agencies were well funded with plentiful resources. At one point there were over 60 people employed to implement the program in contrast to the small, under-resourced staffs at other states with pollution prevention or waste reduction laws.

Toxics use reduction, itself, was a strong concept with a clear message and a well crafted definition. Key activities and concepts developed as the program matured include:

- The reliance on facility planning offered an effective instrument for ensuring that firms assessed toxic chemical use and the availability of alternatives.
- The concept of independently trained and licensed planners, now elsewhere called "third party auditors", provided an opportunity to extend the technical reach of the government and transfer technology or practice information among firms.
- The annual chemical use reporting and its aggregation into an Internet-based, publicly accessible information database provided a means of numeric accountability that has made the program transparent and credible.
- The close working relationship between the public technical assistance branch and the university-based center proved to be beneficial to both.
- As the program matured, the implementing agencies instituted new initiatives such as the Institute's Community Grants Program which extended the program's focus beyond the manufacturers to include concerned citizens.

At the same time, even as the program grew in national and international recognition, there were on-going legislative efforts by external trade groups to kill or weaken the program. By the mid-1990s, several reports from the advocacy community criticized the slow progress of the program. Toward the end of the 1990s, agency staff began working with advocates and business leaders to consider ways to refine and update the provisions of TURA. A special "Blue Ribbon Task Force" convened by the Secretary of Environmental Affairs in 1998 recommended legislative changes in the program to better target the program to "higher hazard toxic substances", reward companies for going beyond compliance, and to broaden the range of environmental impacts that could be included in facility plans. Many of these recommendations were adopted as part of the amendments to the law in 2006, which allowed facilities to engage in alternative planning methods and allowed the state to designate "Higher Hazard Substances" and "Lower Hazard Substances" from the overall chemical list.

So as the TURA program turns twenty it is useful to reflect. This is a successful program. It has stood the test of time and weathered the years well. A re-read of the original text remains impressive. It is a well-balanced law, providing for both state and business responsibilities, appropriate authorities for the state, mechanisms (facility planning) that provide flexible means for compliance, clear, measurable goals, annual data for tracking progress, professionalized public services to assist in implementation, and a secure and steady revenue stream necessary for operations. The bill includes unique, proven mechanisms for policy decisions that involve input from the scientific community and stakeholders. TURA has provided opportunities for businesses to take a leadership role by integrating toxics use reduction into their core business model and voluntarily reduce their use of toxic chemicals when it makes business sense to do so.

5. Papers in this special edition

The papers presented in this Special Edition cover a wide range of topics, from specific technical advances made under TURA to broad assessments of chemicals use policy. These achievements were accomplished by researchers and managers in companies, in universities, environmental associations and by government program staff. In attempting to organize this review, we have decided to start with the specific and move to the more general. We hope this review transmits to the reader the tremendous range of positive outcomes that the Toxics use Reduction Act has either initiated or contributed to over the past twenty years.

5.1. Specific examples of toxic use reduction in action

The successes and the inherent limitations in the Massachusetts TURA are apparent from reading the papers included in this edition of the Journal. The papers by Morose et al., Onasch et al., and Marshall describe specific successful approaches undertaken within TURA to implement the goals of the law, while those of Bondi, Dunagan et al., González-Garcia et al., Nagarajan et al., Atlee, Winnebeck, and Onasch describe the application of TUR techniques in specific applications. Finally, in this section, Ellenbecker and Tsai look at the application of TUR principles to an emerging industry, and Armenti looks at the impact of TURA on worker health and safety.

Morose ("Supply chain collaboration to achieve toxics use reduction") describes one of the most successful approaches used by the program, namely, the use of a supply chain to implement significant process change. TURI, with funding support from EPA, assembled a set of new England companies from the entire circuit board supply chain, and worked with dedicated scientists, engineers and managers from these companies to identify lead-free alternative solders, assemble parts using these alternatives, and subject the parts to the standard range of new product testing. This example, where companies up and down the supply chain in New England came together to develop lead-free circuit boards, shows the power of this cooperative approach to attaining meaningful toxics use reduction.

Another approach that has shown great promise in Massachusetts is the work with communities, non-profit organizations and small businesses to implement TUR on the local level. Onasch ("Small business models created to implement toxics use reduction techniques: Dry cleaning, auto shops, floor finishing, and nail salon sectors assisted in creating safer and healthier work places") describes the considerable success attained by paying attention to the needs of smaller businesses, who often have the desire to reduce their use of toxic chemicals but do not have easy access to the required resources to identify available changes. Almost one hundred TUR projects have been completed by Massachusetts small businesses and community groups, and the successes of many of the funded projects have spread to other businesses and communities.

One important innovation adapted early in the program was the establishment of a research laboratory at TURI. Originally called the Surface Cleaning Laboratory, and now the TURI Laboratory, the lab was initiated to help companies select safer alternatives to their cleaning solvents. The traditionally-used chlorinated hydrocarbons were widely adopted across industry because of their near-universal cleaning ability, *i.e.*, they can remove almost any contaminant from almost any surface. Safer alternatives, however, such as aqueous-based formulations, must be individually tailored to each contaminant and surface. Kikuchi ("Analysis of risk trade-off relationships between organic solvents and aqueous agents: Case study of metal cleaning processes") reviews the risks and benefits of organic solvent versus aqueous cleaning, and concludes that the global impact of aqueous cleaning on balance is less than organic solvents.

The effectiveness of aqueous alternatives was largely unknown twenty years ago, so the TURI Laboratory took on the task of testing the cleaning effectiveness of these alternatives. The TURI Laboratory tested hundreds of alternative chemistries applied to many substrates and surface contaminants, and assembled Web-accessible database so the public can access the results. Although the lab was successful at identifying alternatives for specific applications, the client adoption rate was not as high as the program would have liked. Marshall ("Hands-on assistance improves already successful pollution prevention services of the Toxics Use Reduction Institute's laboratory") describes the success of recent efforts to engage companies at their facilities, demonstrating that cleaning systems developed in the lab can work effectively on the shop floor.

The principles of TUR have been applied in recent years to many specific applications and industries. Bondi ("Applying the Precautionary Principle to consumer household cleaning product development") challenges the often-stated opposition to the Precautionary Principle "…that its application stifles innovation by requiring proof of safety prior to introducing a new technology." She presents the case of quaternary ammonium compounds, sodium hypochlorite, and Triclosan, widely used in surface disinfection and antimicrobial hand washes; after reviewing the evidence for their toxicity, she concludes that the precautionary approach "…effectively eliminates all conventional antimicrobial active ingredients, which introduces a significant challenge for developing an antimicrobial surface disinfectant." After reviewing active ingredients in EPA-registered products, she makes the case for the use of thymol, the active ingredient in thyme oil. Seventh Generation commissioned a series of toxicity tests on thymol; after their successful completion, they launched their first botanical disinfectant, containing thymol, in

January 2010. She concludes that "rather than stifle innovation, the example of thyme oil based disinfectants illustrates that the Precautionary Principle can actually drive innovation and result in safe and sustainable products and solutions."

Dunagan et al., in their review of toxic chemical exposures in the home environment ("Toxic use reduction in the home: lessons learned from household exposure studies"), are not reporting on a successful use of TUR; rather, they have outlined the tremendous opportunity that exists for future TUR activities aimed at this important environment. They conclude that, building on the program's success in reducing toxic chemical use in manufacturing, "…TURA has the potential to extend these benefits to include further reductions in exposure from consumer product use." While TURA specifically applies to products manufactured in Massachusetts, it has not direct jurisdiction over products imported into the state from elsewhere. Recognizing this, the authors recommend that "…ultimately, a coordinated national approach to chemicals is needed."

González-Garcia et al., ("Environmental assessment of green hardboard production coupled with a laccase activated system") attacked the serious problem of formaldehyde emissions from traditionally-made wood-based panels. They performed a comprehensive life cycle assessment (LCA) of a newly-developed alternative technology to produce green hardboard using "…a wood-based phenolic material and a phenol-oxidizing enzyme (*i.e.*, laccase)." They conclude that "…the production of green hardboards using a two-component bioadhesive based on both a wood phenolic material and a phenol-oxidizing enzyme is industrially viable…" but that further research is needed in order to reduce the energy demand of the new system, as well as on the amount required and application conditions in order to obtain the desired mechanical properties.

Traditional flame retardants used in polymeric applications are extremely toxic and persistent, and some emit toxic/corrosive gases during combustion. Nagarajan et al., ("A renewable waste material for the synthesis of a novel non-halogenated flame retardant polymer") studied the flame retardant properties of cardanol, a main component of cashew nut shell liquid, a waste product from the cashew nut industry. Their reactions were carried out in aqueous media, and found that cardanol showed promise as a flame retardant, although more research is needed in order to produce a practical product.

The green building industry has focused more attention in recent years on chemical hazards in building products. Atlee ("Selecting safer building products in practice") describes a number of tools available to assist architects, engineers, and other building professionals in the assessment of alternative building materials. After a general review of available approaches, she presents a detailed evaluation of one tool – the Greenspec Product Guide. Her evaluation of all of the available tools leads her to conclude that "…ultimately a selection must be made from the available options" and that at present we must face "…the messy reality of product selection in practice in the inevitable absence of perfect information."

The issue of children's possible exposure to phthalates has received considerable attention recently. Winnebeck ("An abbreviated alternatives assessment process for product designers: a children's furniture manufacturing case study") uses crib mattresses, whose plastic covers can contain phthalates, as a case study for evaluating various alternatives assessment methodologies as applied to the manufacture of children's furniture. She begins by performing a review of recently-published alternatives assessment methodologies, including that used in TURI's Five Chemicals Study, Green Screen, the TURI-spearheaded State Alternatives Assessment Forum, and others. Winnebeck used the basic elements in these models in a two-step approach to evaluating mattress cover alternatives – a product-level analysis followed by a more detail component-level analysis applied to those products that passed the first screen. She concludes that the two-step approach allowed the complete assessment to be completed in six months, and the manufacturer replaced their vinyl-covered mattress with a waterproof cotton mattress.

TURI has been working with the dry cleaning sector for more than ten years to help them move away from perchloroethylene ("PCE"), a very toxic chlorinated solvent. Onasch ("A feasibility and cost comparison of perchloroethylene dry cleaning to professional wet cleaning: case study of Silver Hanger Cleaners, Bellingham, Massachusetts") discusses the feasibility of using a matching grant as a way to attract a small dry cleaner to switch from PCE cleaning to the new generation of professional wet cleaning machines. TURI provided a matching grant of $17,000 to Silver hanger Cleaners to assist in the purchase of professional wet cleaning equipment; as part of the grant, the owner agreed to allow TURI to track his costs and technical performance before and after the switch. After one year, Onasch concludes that "…both the cleaner and his employees are happy with the new technology…customers are happy with the conversion…" and net operating costs and natural resource use (electricity, natural gas, and water) all decreased. She concludes that the grant process was useful in convincing one dry cleaner to make the switch, that utilities should be interested in pursuing this approach due to energy savings, and that "the establishment of a national professional wet cleaning assistance program would help provide support to cleaners across the country who currently work with PCE on a daily basis."

The principles of TUR can be applied both to traditional industrial processes such as surface cleaning and to newly-emerging technologies. Ellenbecker and Tsai ("Engineered nanoparticles: safer substitutes for toxic materials, or a new hazard?") discuss the potential benefits and possible pitfalls presented by the rapidly growing nanotechnology industry. They conclude that the use of engineered nanoparticles as substitutes for toxic materials "…holds great promise, but also many risks. For every possible application, alternatives assessment tools…must be used to carefully analyze the risks and benefits."

An important concept underlying the TUR Act is the simultaneous concern for environmental and occupational health. Armenti et al., present the case for TUR or, more broadly, cleaner production and pollution prevention (CPPP), as a primary prevention technique for protecting worker health. They evaluated the effect of TUR on worker health and safety at three printed wire board manufacturing facilities covered by the TURA Program. Using a variety of survey instruments, they conclude that, while waste reduction and cost savings are the primary drivers considered by the surveyed facilities, CPPP/TUR had a positive impact on worker health and safety.

The specific examples of toxics use reduction described in the above papers illustrate the wide reach that TUR and its associated tools have attained in the last twenty years. These concrete examples are strong evidence that the vision and hopes of the bill's creators have been realized.

5.2. Toxics use reduction from a policy perspective

Several of the papers in this issue look not at specific examples of TUR in action, but rather at its successes and limitations from a policy perspective. Focusing on Massachusetts, Reibstein and Massey investigate the experiences of Massachusetts companies in working with the law, while Eliason discusses the possibilities for using the Massachusetts process as a model for other states. Morse applies the data collected under the Massachusetts law to Connecticut in an attempt to estimate chemical use in that state. Moving to the international stage, Hughey in two papers evaluates the potential for

voluntary pollution prevention programs, both in general and specifically as they apply to New Zealand. Thorpe describes specific examples of new toxic chemical policy initiatives that have grown from the foundation established by TURA. Finally, Lindsey takes a broad view and suggests "sustainable principles" that might guide society as we move forward (hopefully) towards sustainability.

Reibstein ("The experiences of four corporate officials managing compliance with the Massachusetts Toxics Use Reduction Act") addresses the common misconception that compliance with the law is an unreasonable burden on industry. In order to illustrate his point, he introduces examples of how TUR works in actual practice inside four facilities. His description of the steps taken to implement TURA at Polaroid, AlphaGary, Texas Instruments, and Allegro Microsystems illuminate some of the initial difficulties, but the ultimate great successes, that were obtained when visionary and dedicated industry professionals dedicated their talents and energy to the successful implementation of the Act. He concludes:

> The Act did not require that any of these companies invest a single dollar in any chemical substitutions or process changes, but after doing the plan, and sometimes after receiving assistance, these companies chose to do so. Not all companies will respond this way. But if some will, then surely wider application of the prevention strategies used by TURA deserves active consideration.

The TUR program has made regular, periodic attempts to quantify the successes and limitations of the program. The chemical use data reported annually by the participating facilities, certainly tell much of the story, but it is more difficult to determine *how* chemical reductions were obtained, the *financial costs or savings* accompanying chemical use reduction, and the actual personal experiences of individuals working to implement the Act at their facilities. Massey ("Experiences of Massachusetts companies and communities with the Toxics use Reduction Act (TURA) program") presents and discusses the results of a recent survey of participating facilities done by the program. She concludes:

> The results of the survey and interviews conducted with Massachusetts facilities indicate that facilities are continuing to experience benefits from the TURA program, including improved worker protection and financial savings as well as organizational benefits. Facilities also continue to face challenges, ranging from technical feasibility problems to limitations deriving from customer specifications.

When the law was passed, little was known about the actual process which should be followed in order to evaluate alternatives to toxic chemicals being used by participating facilities. One of the principal analytical tools that were developed to meet this need is alternatives assessment, which formalizes and systematizes the process by which alternatives are evaluated. In 2006 the Massachusetts legislature funded TURI to conduct alternatives assessments for five toxic chemicals of particular concern to the Commonwealth, *i.e.*, di (2-ethylhexyl) phthalate (DEHP), formaldehyde, hexavalent chromium, lead, and perchloroethylene. Eliason ("Safer alternative assessment: the Massachusetts model for state governments") presents a summary of the results of those assessments, and discusses how this approach can be successfully applied to other chemicals in other locations. One of the key findings of this effort was the need to involve interested stakeholders in all phases of the assessment. Many promising alternatives were identified for each chemical, and most of them required further study in order to ensure successful implementation by industry. Eliason concludes that alternatives assessment "…is a useful approach to organizing and evaluating information about chemicals and alternatives, and could be utilized by policy makers as well as industry to help move our economy towards the use of safer chemicals and materials."

One of the hopes of the leaders who worked so hard for the passage of TURA, as described above, was that it would serve as a model for implementation of similar laws in other states. Unfortunately, such programs have been slow to emerge, with only a few states such as Oregon, New Jersey, and Maine enacting similar legislation. Recently the Province of Ontario passed a law modeled on TURA, New York and Connecticut have taken initial steps to develop TUR programs, and TURA has been cited as a key model for California's ambitious overhaul of its approach to regulating chemicals. In preparation for possible legislation, Connecticut scientists were interested in assessing the extent of chemical use in their state. Morse ("Estimated chemical usage by manufacturers in Connecticut") describes the methodology used to apply Massachusetts chemical use data to the Connecticut manufacturing sector in order to estimate the scope of toxic chemical use which might be addressed by a new Connecticut TUR program. He was able to develop credible estimates for total toxic chemical use and use of carcinogens and reproductive hazards, but with great uncertainties as to chemical use by different industrial sectors. This underscores the need for actual TUR reporting in each state, so that the problems of that state can be targeted.

Moving from the state level to the international stage, two papers by Hughey are included in this edition. The first, by Hughey and colleagues, ("A review of international practice in the design of voluntary pollution prevention programmes") reviews the recent global impetus towards voluntary approaches to industry-wide pollution prevention. A detailed review of efforts in five countries from around the world identified nine specific features characteristic of successful programs, ranging from "adequate and consistent funding" to "transparent provision of program results." In a second paper ("Voluntary pollution prevention programs in New Zealand – an evaluation of practice versus design features") he then evaluates nine programs employed by five regional and district councils in New Zealand against those nine "Best Practice" design features. While finding that most of the programs incorporated most of the design features "on paper", many of the elements were generic and lacked specificity and depth; for example, none of the programs had any elements that were industry specific. He is particularly critical of the lack of setting specific goals for pollution prevention – a key element in the Massachusetts TUR Act.

Thorpe begins her article ("How the Toxic Use Reduction Act continues to promote clean production internationally") with a statement that brings joy to the hearts of those who have worked for twenty years to make TUR a success: "The Massachusetts Toxic Use Reduction Act (TURA) continues to be a catalyst for pollution prevention planning in regions far beyond its state's jurisdiction. This is due in large part to the success of the Act." She goes on to describe three international programs that she believes had their genesis in TURA, *i.e.*, the Sewer Use Bylaw in Toronto, Canada; the European Union's REACH chemicals legislation, and the international campaign by Greenpeace in Asia and Latin America to achieve zero discharge of hazardous substances into rivers. She describes each of these efforts in some detail, identifying their successes and weaknesses, and analyzing TURA's impact on their implementation. One is struck by how different these programs are; that Thorpe can identify TURA's strong influence on all of them is testament to TURA's fundamental strengths.

Finally, Lindsey ("Sustainable principles: common values for achieving sustainability") proposes what he believes are "sustainable principles," rooted in techniques of pollution prevention, that "can optimize resource utilization across all system components for the entire life cycle of the systems." After reviewing the

sustainability literature, he proposes the following fundamental sustainable principles:

Principle #1:
Improved Sustainability is achieved through **Reducing Wastefulness**.

Principle #2:
Improving Quality Improves Sustainability.

Principle #3:
Sustainability is best achieved through Implementing **Better Systems**.

We believe that this statement of principles is an excellent way to conclude this special edition. The Massachusetts TUR program, at its core, involves companies, government workers, and the public working together to develop and implement **better systems** that **reduce wastefulness** through **improved quality** of products and manufacturing processes. If the past twenty years have taught the people of Massachusetts anything, it is that individuals from all parts of society can work together to improve the quality of our workplaces and our environment, as long as they are dedicated to a common goal and a regulatory framework is in place that encourages all parties to work together in a creative way to reach that goal.

The world faces severe environmental problems, including toxic chemicals but encompassing much more in the form of global warming and natural resource depletion. It is our hope that this special edition will encourage others from throughout the world to join us in the effort to reduce toxic chemical use and make ours a truly sustainable society. It is up to all of us to rededicate ourselves to working even harder over the next twenty years to make this planet a safer, healthier, and sustainable place for our children and their children for many generations.

References

Ackerman, J., 1983. Waste siting law is a hit at hearing. The Boston Globe, 1.
Dumanoski, D., 1983. Right-to-know bill on toxic materials pushed. The Boston Globe, 1.
Harvard Kennedy School, 2005. Ash Center for democratic governance and innovation. Toxics use reduction program. Available at: http://www.innovations.harvard.edu/awards.html?id=3833.
Langner, P., 1980. Voluntary approach to hazardous waste. The Boston Globe, 1.
Massachusetts Department of Environmental Quality Engineering (MDEQE), Division of Hazardous Waste. 1981. The hazardous waste problem and its management.
Massachusetts executive office of labor and workforce development (MEOLWD). Right to know. Available at: http://www.mass.gov/?pageID=elwdmodulechunk&L=4&L0=Home&L1=Government&L2=Departments+and+Divisions+%28EOLWD%29&L3=Division+of+Occupational+Safety&sid=Elwd&b=terminalcontent&f=dos_rtk_landing&csid=Elwd, 2010.
New Jersey technical assistance program (NJTAP). The New Jersey pollution prevention act. Available at: http://www.ycees.njit.edu/njtap/njppa.htm, 2001.
Oregon department of environmental quality (ODEQ). Toxics use and hazardous waste reduction. Available at: http://www.deq.state.or.us/lq/hw/tuhwr.htm, 2010.
Provost, D., 1982. Article and comment: the Massachusetts hazardous waste facility siting act: what impact on municipal power to exclude and regulate? Boston College Environmental Affairs Law Review 10, 715.
Sirianni, C., Friedland, L., 2001. Civic Innovation in America: Community Empowerment, Public Policy, and the Movement for Civic Renewal. University of California Press, Los Angeles and Berkeley, pp. 118, 122.