

Expansion of the object of surveillance for occupational accidents: history and challenges underwent by a reference center aiming at prevention

Rodolfo Andrade de Gouveia Vilela ¹
 José Marçal Jackson Filho ²
 Marco Antônio Pereira Querol ³
 Sandra Francisca Bezerra Gemma ⁴
 Mara Alice Conti Takahashi ⁵
 Marcos Hister Pereira Gomes ⁵
 Sandra Renata Canale Duracenko ⁵
 Ildeberto Muniz de Almeida ⁶

Abstract *The Surveillance System for Occupational Accidents (Sistema de Vigilância em Acidentes de Trabalho - SIVAT) established by Reference Center for Workers' Health (Centro de Referência em Saúde do Trabalhador - CEREST-Piracicaba) in 2003 represents an experience consolidated according to the guidelines formulated by the National Network for Integral Care of the Workers' Health (Rede Nacional de Atenção Integral à Saúde do Trabalhador - RENAST). The present article analyzes the history and development of SIVAT at CEREST - Piracicaba from the perspective of cultural-historical activity theory. The historical data comprise interviews, documents and observations performed by the researchers. Analysis showed that the studied activity underwent two cycles of expansion. During the first cycle, CEREST actions sought to adequate the targeted companies to the legislation in vigor. During the second cycle, actions aimed at introducing changes relative to organizational determinants in the targeted companies that CEREST staff identified as causes of accidents. A new modality of formative intervention, called Change Laboratory (CL), seems to be useful to attain the goal of prevention; it involves analysis of the causes of accidents, activity remodeling and implantation of solutions by developing agency in the targeted organizations.*

Key words *Workers' health surveillance, Occupational health services, Working conditions, Expansive learning theory*

¹ Departamento de Saúde Ambiental, Faculdade de Saúde Pública, Universidade de São Paulo. Av. Dr. Arnaldo 715, Cerqueira César. 01246-904 São Paulo SP Brasil. ravilela@usp.br

² Fundação Jorge Duprat Figueiredo de Segurança e Medicina do Trabalho, Centro Regional do Paraná. Curitiba PR Brasil.

³ Programa de Pós-Graduação em Administração, Universidade Federal de Sergipe. Aracaju SE Brasil.

⁴ Programa de Pós-Graduação em Ciências Humanas e Sociais Aplicadas, Faculdade de Ciências Aplicadas, Universidade Estadual de Campinas. Campinas SP Brasil.

⁵ Centro de Referência em Saúde do Trabalhador "Dr. Alexandre Alves", CEREST Piracicaba. Piracicaba SP Brasil.

⁶ Faculdade de Medicina, Universidade Estadual Paulista (UNESP). Botucatu SP Brasil.

Introduction

Workers' Health Surveillance (Vigilância em Saúde do Trabalhador - VISAT) is one of the strategic axes of the National Policy for Workers' Health¹, being understood as a permanent quest to broaden its scope of influence on health determinants and conditioning factors related to the work process².

VISAT is considered a strategy for action that is *continuous and systematic over time, aiming at detecting, learning about, investigating and analyzing the determinant and conditioning factors of health disorders related to the work process and environment as concerns their technological social, organizational and epidemiological aspects to plan, perform and assess interventions relative to such aspects to eradicate or control them*³. The corresponding guidelines within the Brazilian national health system (Sistema Unificado de Saúde / Unified Health System – SUS) include aspects: universality, integrality, multi-institutional approach, social control, hierarchization and decentralization, interdisciplinarity, research – intervention, and the transforming nature of interventions³.

The available legal and operational support notwithstanding, several studies showed that the advancements made by VISAT are rather conceptual, instead of involving actual programmatic actions in the covered area^{2,4}. According to Machado⁵, VISAT might be characterized as a fleeting and regionalized practice. A fleeting practice due to the instability and limitations of its practices, derived from constant changes in the orientations given and staff within the municipal setting. A regionalized practice, because in spite of many attempts, the instances of actual implementation of VISAT systematic actions are few, have not yet started or are incipient in many locations².

The assumption underlying surveillance actions is the possibility to prevent the occurrence of health problems among workers, which manifest as suffering, biological abnormalities, damage, wear, disease, injuries or accidents. Since VISAT action focuses on interventions targeting the work environment and processes and forms of organization likely to cause health problems, it includes the dimension of prevention of the workers' health. This is to say, only surveillance intervention actions might break the cycle of disease and death at work. This dimension of prevention is mainly an attribution of the National Network of Integral Care of the Workers' Health (Rede Nacional de Atenção Integral à Saúde do

Trabalhador - RENAST) through Reference Centers for Workers' Health (Centro de Referência em Saúde do Trabalhador – CERESTs) meant to be centers for coordination of effective actions in the covered territorial area, as well as nodes of connection within the network itself.

Assessment of the surveillance actions performed by RENAST from its creation in 2002 led scholars^{2,4,5} to raise doubts as to the existence of a consolidated culture relative to the surveillance of the workers' health. RENAST second Inventory⁶ showed that VISAT actions are performed at more than half of CERESTs (58.4%), however a nationwide, more detailed assessment is still required.

The present article describes an analysis of the experience with the Surveillance System for Work Accidents (Sistema de Vigilância em Acidentes de Trabalho, SIVAT) that took place at the CEREST of Piracicaba County, São Paulo (SP), Brazil.

Inspired in the North American SENSOR (Sentinel Event Notification System for Occupational Risks) system⁷, SIVAT-Piracicaba gathers information from the emergency and urgent care network, which is then sent to CEREST-Piracicaba for systematization and analysis so as to launch intervention actions to prevent future occurrences. Some of SIVAT's advantages are: ability to detect and act on priorities and similar events concerning a given group of exposed workers; assessment of occupational health prevention and control measures adopted by the companies under surveillance; easy reproducibility and adoption of more scientific parameters of analysis⁸.

The defining characteristic of CEREST-Piracicaba is its focus on surveillance, for occupational accidents (OA) in particular⁹, which contributes to its ability for inter-institutional coordination. Thus the conflict with the work sector is partially overcome, by engaging unions and a network of social partners, including professionals from unions, universities, the SUS network and companies interested in reframing their health and safety problems, among which the local print media stands out¹⁰.

In the course of almost two decades CEREST-Piracicaba signed several sectoral agreements to improve working conditions, performed interventions on and analysis of work environment and processes, investigated severe and fatal occupational accidents, hundreds of notices of violation, notifications and implemented negotiating tables. It has active participation in the

organization of Municipal Week of Accidents Prevention - which in 2015 completed 20 years of existence – whose purpose is to divulgate topics relevant to the field of occupational health to specific audiences and the overall population. CEREST-Piracicaba obtained wide acknowledgement, in addition to receiving national awards. Together with researchers from universities in the state of São Paulo (School of Public Health, University of São Paulo/Escola de Saúde Pública, Universidade de São Paulo – FSP-USP), and School of Medicine of Botucatu, São Paulo State University (Faculdade de Medicina de Botucatu, Universidade Estadual Paulista – FMB/UNESP) CEREST-Piracicaba staff participated in the design and application of Model for Analysis and Prevention of Accidents (MAPA)¹¹, as well as in the development of Forum of Analysis, Accidents Prevention and Related Aspects¹², which in June 2016 held its 54th meeting.

How did CEREST-Piracicaba combine epidemiological information with intersectoral surveillance actions based on priorities and research/intervention involving the participation of different social actors? Which strategies were used to make invisible organizational issues, which largely account for the occurrence of health problems, visible? Which knowledge and skills did its staff develop?

Considering the alarming situation in Brazil as concerns the magnitude and severity of the workers' health problems⁴, an investigation of the development of the aforementioned initiative over time is fully justified to thus contribute to the consolidation of public policies for surveillance and prevention.

Theoretical framework and methods

The present was a qualitative study corresponding to modalities case study^{13,14} and documentary research¹⁵. The main sources of data were academic studies published by CEREST-Piracicaba staff, annual plans and corresponding accountability reports, which are available online at the service website. The present article was collectively planned and discussed at a workshop that included the participation of undergraduate students from the partner universities and CEREST-Piracicaba technical staff. The study complied with the ethical norms for research involving human beings in force.

The theoretical and methodological framework underlying data analysis was cultural-his-

torical activity theory¹⁶. According to it, human beings are engaged in productive activities, which differ by their object¹⁶. In contrast to goals, which are circumscribed to a definite time and place, the object of an activity is more open, complex and lasts in time, because it is related to a social human need; it is a source of personal and social meaning. Therefore, the study of an activity system begins by the identification of the object that orients the actions of individuals¹⁷. Engeström^{16,17} elaborated on the triangular conceptual model originally formulated by Leontiev to analyze activity systems (AS) (Figure 1); this model facilitates the understanding of the multiple mediations that take place within the system. The elements that compose an activity system are: Subject (including individuals and groups), Object (specific to each activity system), Community (which includes partners, consumers, etc.), Tools (conceptual and practical), Rules (internal or external norms, deadlines, etc.) and Division of Labor (who does what, hierarchy)^{17,18}.

Human activity develops empirically as a dialectical process of double stimulation, which begins by a problem or difficulty subjects face (first stimulus). To overcome difficulties or contradictions, subjects look for means (second stimulus) in the attempt to balance the situation. Such mediators might be tools or concepts, technical or social devices that enter in operation and attenuate or balance the previous situation and in turn modify the functioning of the system, thus favoring the onset of cycles of expansive learning. Thus, efforts are made to develop new instru-

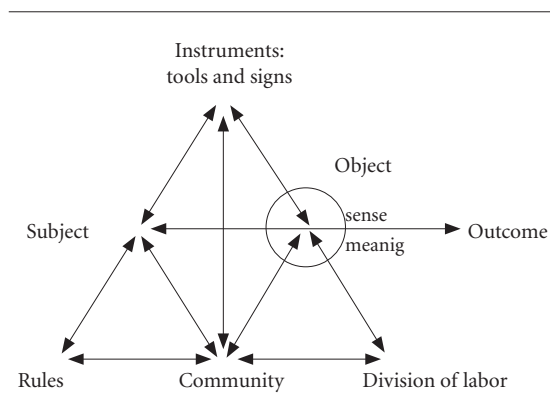


Figure 1. Activity system.

Source: Engeström^{16,17}.

ments, new rules, a new division of labor, enlarging the community, to apprehend the object and attain the desired outcomes^{17,18}.

Historical analysis allows detecting contradictions between the mediators of activity systems, which are a driving force for learning and change and lead to innovations in both mediators and object. Awareness of contradictions might facilitate the development of an activity by focusing on developmental actions aiming at resolving them in a creative manner. With this, a new way of acting sets in, which modifies the system of relationships to which the subject – actor belongs¹⁸.

By understanding the past it is possible to comprehend the present, foresee perspectives and future trends.

Ideas arising from a new object of activity make actors look for new cooperative forms of relationships, which once they are found help in the elaboration of new ideas and in the future consolidation of practical innovations¹⁹. The zone of proximal development (ZDP) of an activity system *is the distance between the present everyday actions of individuals and the historically new form of the societal activity that can be collectively generated as a solution to the double bind potentially embedded in the everyday actions*¹⁷.

The development of an activity system is a dialectical non-linear process, which occurs as cycles of expansive learning. This is a complex process that might require several years and includes countless successive smaller cycles of expansive learning that take place in parallel and promote the inventions needed for the development of the larger cycle. A cycle of expansive learning is completed when the activity system undergoes a qualitative transformation²⁰.

To clarify the selected perspective, we approached the determinants of work-related risks as contradictions or structural tensions within an activity system, which favor the occurrence of anomalies and unexpected outcomes, such as accidents, loss of quality, reworking and environmental damage^{16,18}. These aspects are usually invisible to inspectors, while any analysis of them demand mastery of the systemic socio-technical approach, which goes beyond simple verification of the presence or absence of risk factors, understood here as conditioning factors, i.e., aspects usually visible on external observation; the majority of such factors is considered in occupational safety health (OSH) regulations.

The development of SIVAT at CEREST-Piracicaba is here analyzed from the perspective of the

expansive development of activity systems^{17,18}, understood as the set of actions and interactions of the subject vis-à-vis the object and mediated by technical and social artifacts²⁰. The emphasis falls on historical events and significant changes occurring in activity systems.

According to activity theory, events might be defined as actions or innovations that transform the structure of an activity. However, the events considered to be relevant are those *occurrences that have momentous consequences in history*²¹.

The criterion to consider an event as historical and include it in the present narrative was consensus, according to the experience of the subjects involved in the activity. This is to say, events the subjects considered to have produced changes in the activity system and that represented an innovation by comparison to the actions developed until that moment. Initially, based on annual reports, we selected and classified events in chronological order and according to their similarity, which resulted in categories surveillance, educational and negotiation actions. Next these actions were analyzed according to the selected theoretical framework, and the ones that led to changes in the structure of the activity system were chosen. These actions were considered to be historical events. In the construction of the narrative, the development of the targeted activity system was divided into smaller cycles, here denominated subcycles, which were described based on the changes in the object^{18,20}.

The main hypothesis of the present study was that a systemic approach to the prevention of accidents leads to the expansion of the object of surveillance, which at an earlier time was limited to the visible risk factors (technical aspects), particularly the ones considered in norms, to gradually come to include organizational issues.

Historical analysis of activity systems might help to understand the constitutive elements of the cycles of development and expansive learning, thus providing new perspectives for the future.

Results

From the perspective of the object of surveillance, the historical events with significant impact on CEREST-Piracicaba's experience and that drove the development of SIVAT corresponded to two subcycles per complete cycle and a total of two full cycles of expansive learning, which are summarized in tables 1 and 2 and described below.

Surveillance for occupational accidents at companies according to occupational safety and health standards (1997-2016) – 1st cycle of expansive learning

Occupational accidents (OA) surveillance began in 1997, when a new team from the Workers' Health Program (WHP), Piracicaba, in partnership with an auditor from the Labor and Employment Ministry (LEM) and representatives from workers' unions, combined a system of epidemiological information with priority-oriented intervention actions²¹ in agreement with VISAT guidelines³. OA occurrences were approached as sentinel events⁷, the origins of which were thoroughly investigated and interventions were performed targeting their causes, all according to the causal tree method²².

In the period from 1997 to 2016, although the overall goal was to act on the determinants of OA as recommended by VISAT guidelines, the object of the activity system was centered on the attempts to adequate the work conditions at companies to the regulations in force, assuming that compliance with the latter would reduce the occurrence of OA. For this purpose the companies and sectors with the highest rates of OA were selected and a system of information on OA (Instrument) was implemented.

The first instrument used was analysis of Work Accidents Communications (Comunicações de Acidentes de Trabalho - CAT) (1997-2003). This analysis allowed identifying the companies that represented a local priority in the terms of OA rate. However, the information available concerned only the formal labor market (Consolidation of Labor Laws / Consolidação das Leis do Trabalho – CLT), while data collection by the National Institute of Social Insurance (Instituto Nacional do Seguro Social – INSS) local agency and later processing by the information system for data processing (called SISCAT) demanded too much time. As a result, this early instrument proved to be poorly practical, especially to trigger surveillance actions for severe and fatal cases, which required prompt intervention.

Introduction of a new program, called WEB CAT, by the Social Security in the beginning of the 2000s, whereby CATs became notified via Internet, did not improve actual surveillance for severe and fatal injuries as was initially expected. The reason was that it blocked the access to the printed CAT forms, available under the older system, which thus come to be collected by DAT-APREV (Social Security Technology and Infor-

mation Company) – Rio de Janeiro (RJ). For this reason, CEREST-Piracicaba needed to develop an alternative instrument, a notification and surveillance system of its own, to enable quick and broad-encompassing action and including also accidents occurring in informal labor settings.

Articulation of information and action

Implantation of SIVAT-Piracicaba allowed articulating the epidemiological information collected from the emergency and urgent care network with priority-oriented surveillance actions³. Upgrade of the pilot project¹² to the countywide scale was achieved through a partnership with universities through research projects (Community enlargement). As a result, SIVAT was transformed into a systematic and permanent public policy for surveillance, which operates to this day.

SIVAT attained full operation in 2003. This is a systematic, continuous-flow program that targets severe and fatal events, as well as the ones involving youths under 18, which are dealt with as sentinel events, thus allowing for intervention at both the original site and at companies with high OA rates so as to meet some of VISAT assumptions^{8,23,24}.

During the first subcycle (subcycle 1.1 in Chart 1) surveillance and intervention at the workplace sought to adequate the latter to the legislation in force aiming at reducing the OA rates (Object). Considering that similar risks were detected in several companies belonging to one and the same sector, for instance, machines without protection in the baking industry, construction lifts in civil construction, and rotating machines in the paper and paperboard industry, as well as staff limitations (Subject limitations), a strategy grounded on collective interventions based on sentinel events was idealized (subcycle 1.2 in Chart 1). Named *Cast Net Operation*, this strategy allowed for the engagement of companies and their representatives, unions, training agencies, other public agencies, such as the Health Surveillance Agency, LEM and the Labor Prosecutor Office (LPO), in sectoral forums, which afforded room for dialogue and articulation of actions (Community enlargement). However, analysis of the agreements implemented along that period shows that the stipulations introduced mostly sought to comply with standards and addressed risk (conditioning) factors visible to inspectors (Object). The municipal agreement on protection for construction lifts in civil construction, triggered by two deaths involving un-

Chart 1. Summary of the strategies and outcomes of the surveillance initiatives performed in the 1st cycle.

1 st cycle/ period	Strategy	Outcomes/impact
Subcycle 1.1 1997-2008	<p>1. Surveillance of the companies with the highest rates of accidents followed by systematic intervention for severe and fatal cases.</p> <p>Object: adequacy of companies to OSH regulation.</p> <p>Instrument: epidemiological information (CATs or SIVAT) to orient intervention priorities.</p> <p>Subject: WHP agents in partnership with LEM auditor.</p> <p>Community: unions' representatives.</p> <p>Companies and workers had limited participation.</p> <p>Rule: company-by-company action (fragmented).</p>	<p>Ações orientadas por prioridades.</p> <p>Primeiro período detecta que 20 empresas respondem por 45% dos acidentes no município⁹. Segundo período amplia notificação para mercado formal e informal. Intervenção em aspectos previstos em normas. Impacto limitado. A idéia do SIVAT é implantada em outros municípios da região e do Estado. Acidentalidade permanece alta. Aspectos organizacionais ficam invisíveis, intocados. Postura reativa da empresa.</p>
Subcycle 1.2 2003- 2016	<p>2. Cast Net Operation: sectoral action on sentinel cases and specific risks.</p> <p>Object: adequacy of the full set of companies to legal norms.</p> <p>Instrument: sectoral collective notification;</p> <p>Subjects: Cooperation Agreement with LPO, which brought more autonomy to the subjects' action without political interference.</p> <p>Community: enlarged via inter-institutional forums.</p>	<p>Broader reach of collective actions.</p> <p>Created room for dialogue. Increased adherence and articulation with public professionals and private companies.</p> <p>Cooperation with LPO brought greater autonomy and respect to the service.</p>

protected lifts, and an agreement with the paper and paperboard industry, triggered by the death of a worker who got caught between the cylinders of a paper drying machine in 2000, are examples of the work performed along that period⁸.

The *Cast Net Operation* was adopted as a valid strategy for other intervention initiatives, such as the ones involving the baking industry²⁴; sugarcane workers' lodging^{25,26}; jewelry and bijoux manufacturing²⁷; woodwork, the pottery, heavy clay and bricks industry; professional motorcyclists; supermarkets, etc. Narrowly focused and fragmented action (previous Rule) was potentiated through inter-institutional articulation, which allowed for community enlargement and commitment, among other aspects.

A fruit of a partnership with labor public attorneys from the LPO 15th region, CEREST-Piracicaba and the 15th Region Labor Regional General Prosecutor Office signed a Technical Cooperation Agreement²⁸, which is crucial to ensure independence and more autonomy to the surveillance agents, especially when their work involves initiatives with greater impact on the more conservative sectors²⁶. This connection with LPO also made CEREST-Piracicaba gain respect from companies and society at large (Community).

Chart 1 summarizes the main strategies adopted along the first cycle and its outcomes and impacts.

Interestingly, although the object was limited to actions on the conditioning factors grounded on the standards in vigor, the enlargement and greater involvement of the community through *Cast Net Operation* resulted in significant innovation and positive impacts, such as reduction of the occurrence of accidents involving paper making machines and in the baking industry, reframing of the problems related to sugarcane workers' lodging, etc., which influence the recognition gained by CEREST-Piracicaba to this day⁹.

However, the enforcement approach proved to have limited impact, because the rate of OA did not decrease in some of the targeted companies, even after more than 10-year surveillance by unions and basically meeting the legal stipulations²⁹. This was a highly relevant finding, representing the main contradiction in SIVAT action along the first cycle. Figure 2 represents SIVAT activity system and the most significant contradictions during the first cycle.

The innovations (new artifacts, new rules) introduced by the staff during the first cycle allowed for the development of SIVAT, as e.g.,

through *Cast Net Operation*, which enlarged the community, granted greater independence and autonomy to the professionals (Subject) and attained more effective outcomes. However, new developments proved to be necessary to address organizational issues, as is discussed next.

WA surveillance with an eye on work organization (2006-2016) – 2nd cycle of expansive learning

The second cycle unfolded under the influence of a convergence between concerns relative to OA surveillance actions and surveillance and care actions targeting RSI/WMSDs (repetitive strain injury/work-related musculoskeletal disorders). A true epidemic of RSI/WMSDs cases began starting at the end of the 1990s, occupying a central position among the demands for sur-

veillance and care at workers' health services³⁰. Without conceptual tools (Instruments) to deal with and act on aspects of work organization (Object), CEREST-Piracicaba elaborated a project and obtained funds from the Health Ministry, which allowed hiring multidisciplinary staff (Subject enlargement) and provided resources to deliver a specialization course on ergonomics and ergonomic work analysis – EWA (Instrument). The staff's appropriation of ergonomic work analysis and its concepts exerted considerable influence on the understanding of the work-health relationship. The reason is that in its earlier practice, the staff focused on the notion of risk factors, which did not consider organizational issues. In the classical approaches, embodied in the Brazilian legislation, risk is reduced to the presence or absence of technical or environmental factors (and more particularly the visible

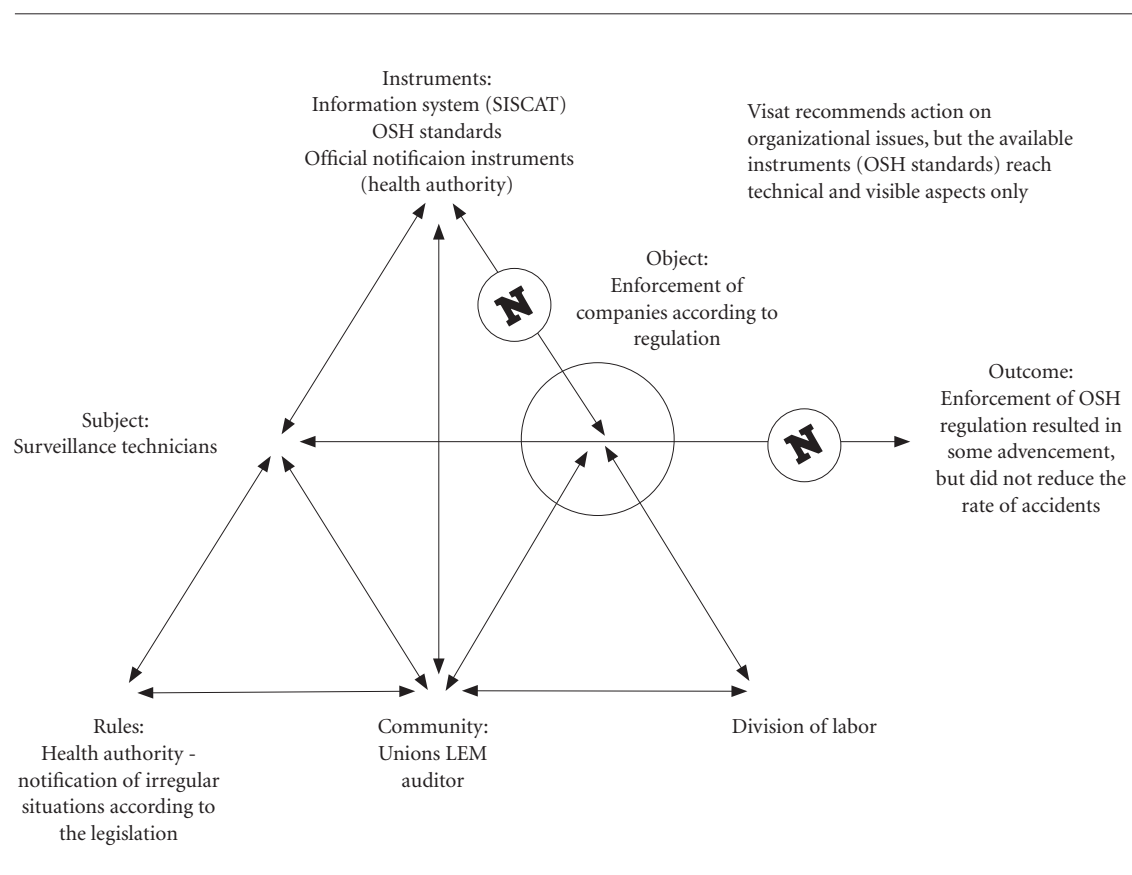


Figure 2. Activity system of Occupational Accidents Surveillance – SIVAT – in the first cycle.

ones), while their relational nature is not taken into account, and thus cannot be associated to the health problems of workers³¹.

Inclusion of the aforementioned new approach was a turning point for the activity system, and thus reached the level of critical historical event¹⁹. The reason is that it changed the everyday practice of the activity object, which was extended to the work organization as determinant of the occurrence of workers' health problems. However, such enlarged object gave rise to tension and triggered, even though empirically, the onset of changes in other elements of the activity system of surveillance; new instruments, new initiatives, (new division of labor) and new partnerships (community enlargement) were therefore needed to attain the new object.

A second research project was developed based on ergonomics, which among other goals sought to explain why the rate of accidents had not decreased in the companies subjected to surveillance and that at least partially met the RNs³². Partnership with universities enabled the actual investigation of six companies based on EWA³³ and MAPA^{11,34}, which was developed and tested in that study. Both approaches gradually come to be included in the surveillance toolbox, especially relative to the most complex cases of severe and fatal injuries.

According to the MAPA approach, to understand the origins of an accident it is crucial to first understand the usual work practices, their variability and the strategies adopted by workers. In this way it is possible to make the organizational factors (latent conditions) become visible, while they remain hidden when conventional tools, such as norm-based inspection, are used.

To reinforce the thus developed methodological instruments, a Work Accidents Forum was launched in 2008 as a place for divulgation of the organizational approach, as well as to deconstruct the practice of blaming victims for accidents. The Forum further includes initiatives for continued education, courses, online debates, distribution of videos and news and a *Facebook* page, among others, so as to develop a social network targeting prevention¹².

However, the aforementioned innovations proved to have limitations in the situations to which they were actually applied. Both MAPA^{11,34} and EWA³³ are powerful tools to understand the determinants of risks in the work organization by establishing consistent diagnoses. These tools need to be actually employed to stimulate the agency of professionals and organizations by

means of a more broadly encompassing social construction. For this purpose the staff needs to have proper mastery of methods for the design and transformation of the working conditions.

To overcome the diagnosis and attain prevention through changes in organizational aspects, the staff launched a Thematic Project "Occupational accidents: from socio-technical analysis to the social construction of change" (FAPESP grant #2012/04721-1); its aim as described in Theme 1 is to establish diagnoses related to formative interventions through the use of the Change Laboratory (CL) method^{17,18,20}. As a pilot project, CL was applied at CEREST-Piracicaba aiming at adapting the method and potentiating surveillance actions³⁵. Among various possibilities, it is expected that CL might serve as a tool for formative interventions to promote the agency of the internal actors at organizations so as to introduce changes in their activity systems to become more sustainable and healthy.

Discussion: from surveillance to prevention, new challenges and future perspectives

Inclusion of the VISAT object (action on determinants, exposures and consequences) into practice stimulated the staff to develop tools and methods to meet the demands in actual practice. Historical analysis including elements of activity theory proved to be consistent to understand the progression of the object of surveillance and its cultural artifacts, which compose the unit of this activity system.

To overcome the insufficiency of the prevailing practice of inspection, which focuses on visible and standard related aspects, CEREST-Piracicaba staff sought to translate, include and consolidate new methods to understand and transform the work determinants that influence the workers' health. In addition to epidemiology and social participation constructs, which are the pillars of VISAT, new conceptual grounds derived from activity-oriented ergonomics and organizational analysis of OA³⁶ were added to CEREST-Piracicaba tools. Along this process, CEREST-Piracicaba developed more links with universities and the public and private sector, and links and partnership with the mass media were sought for.

Along such development, together with universities (subcycle 2.2 – Chart 2) CEREST-Piracicaba staff is testing a new modality of intervention, which might lead to a new expansion of the object of the activity.

The CL method was selected because it promotes a collaborative environment of learning involving researchers and practitioners and allows for synchronic association and engagement of the internal actors in organizations aiming at understanding contradictions related to ongoing and historical problems, thus enabling the shift to the stage of designing, testing and development of solutions^{17,20}.

The diagram in Figure 3 depicts ZDP as a hypothesis explaining the developmental trend of the SIVAT object so as to further develop and innovate its strategies for prevention.

On the horizontal dimension (agency), one might notice an expansion from external individual agency (auditors, inspectors, external specialists) to plural and collective, also including internal agency. On the vertical dimension (object nature) one might notice a progression from a technical visible and standard-based object toward an object of systemic socio-technical nature. The diagonal arrow (solutions) depicts the

progression from ready-made external solutions to internal innovations developed by the productive activity actors.

Quadrant 1 depicts the traditional inspection action of the state enforcement, which focuses on individual production units (company by company). In quadrant 3, the standard-based approach is expanded to collective sectoral action, namely, the first-generation “*Cast Net Operation*” (e.g., baking industry²⁷, sugarcane workers’ lodging³⁷ and others).

The object’s expansion towards work organization aspects is depicted in quadrant 2, in which concept-grounded diagnostic attempts, involving the help of specialists and the knowledge of workers interviewed at the workplace, are associated with instances of negotiation, in which CEREST staff and external supporters still play the leading role. Wider expansion is depicted in quadrant 4, in which in-depth analysis is combined with formative intervention, which might ensure the agency of the internal actors and the

Chart 2. Summary of the strategies, outcomes and impacts of the second SIVAT Piracicaba cycle.

2 nd cycle period	Strategy	Outcome / impact
Subcycle 2.1 2006-2009	<p>2.1 SIVAT improvement. Strategy: 2nd FAPESP research project involving universities, LPO, LEM and workers’ unions</p> <p>Object: work process at selected (high priority) companies and the sugarcane industry.</p> <p>Instruments: Model for Analysis and Prevention of Accidents (MAPA); diagnosis is included in negotiations with companies, unions and LEM;</p> <p>WA Forum, developed as a continued education strategy, including in-person and virtual activities (courses, virtual debates, videos and Facebook).</p>	<ul style="list-style-type: none"> - The internal actors in companies did not participate in the diagnosis. During negotiations, they agreed to changes in narrowly focused technical aspects, but resisted organizational changes, the challenges posed by which remained. - WA Forum consolidated, with satisfactory access to its webpage and satisfactory attendance to in-person meetings. 2.1.3 Training in and onset of MAPA application at RENAST-SP. Incipient social network targeting prevention. - The activity system with an enlarged object coexists with the older system, subjected to tension resulting from the demands and quantitative goals. Paradoxes and tension emerged between the new and the older systems.
Subcycle 2.2 2013 - 2016	<p>2.2 Attempts to overcome the organizational diagnosis and attain prevention through involvement of the internal actors in organizations. New (thematic) research project sought to overcome the diagnosis and develop tools for formative intervention.</p> <p>Instrument: Change Laboratory (CL). In the pilot stage, the staff decided to apply a CL intervention to reshape CEREST’s activity system.</p>	<ul style="list-style-type: none"> - The initial interventions are still in course. The staff applies CL to the surveillance system, thus it succeeds in reshaping and developing expansive solutions: new division of labor, new rules and community enlargement³⁷.

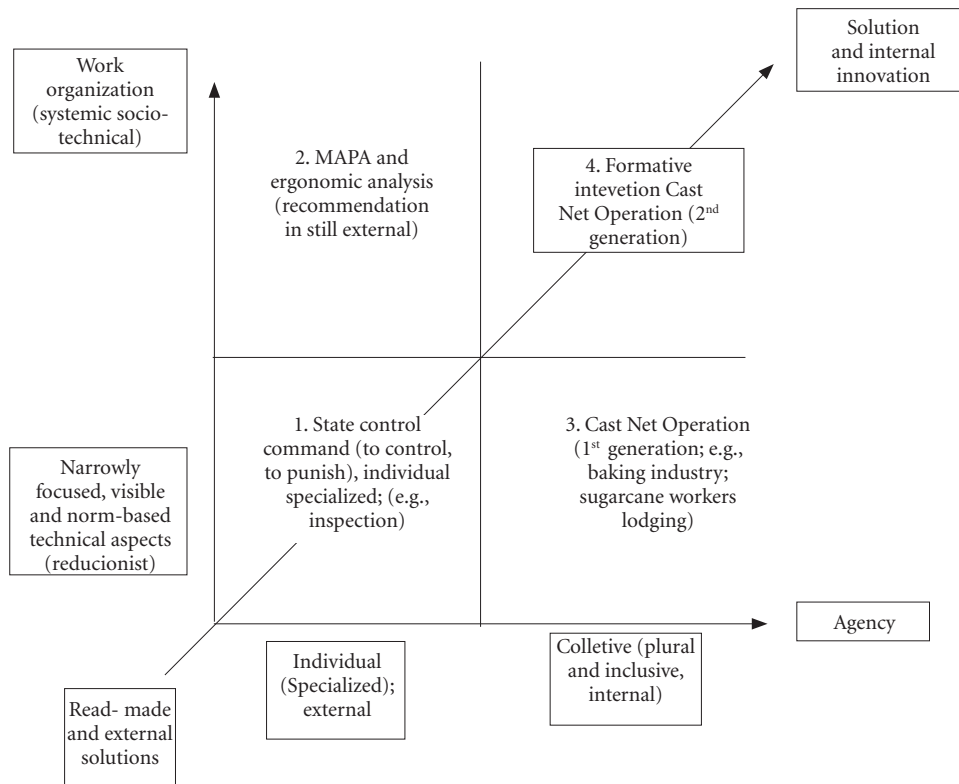


Figure 3. Zone of proximal development – WA surveillance, CEREST-Piracicaba.

formulation of innovative solutions. The proposed zone of proximal development points to the emergence of a new model for SIVAT.

Final comments: The object's complexity calls for new changes in SIVAT

The analysis performed shows that the two cycles and subcycles identified are not stagnant, but coexist within a same time and space dimension. The implementation of the object of prevention created tension within SIVAT. The object of prevention calls for the actors to use and appropriate themselves of tools more adequate for the engagement of subjects. However, the traditional health authority tools, as described in the law, lead officials to actions restricted to the aspects ruled by regulations.

The efforts to develop the object, however, are hindered by the limitations of the power public agents have to make company actors transform their working conditions, which are increasingly influenced by organization and management

modalities deleterious to health. When power is limited to the observable aspects established in the law, and pathogenic organizational issues are not considered in regulations, might there be any means to sensitize or compel company actors to change? What other alternatives are possible? How to overcome such contradiction? Is the solution possible only within the scope of the CEREST activity system?

The narrative on the historical development of SIVAT shows that several contradictions were overcome. From the historical point of view, the inclusion of ergonomics and MAPA was associated with changes in how accidents are understood. Such expansion involved a change in the philosophical perspective, a shift of paradigm that led to understand the object not as an isolated and independent part of a system, but as a systemic or dialectic object, the components of which can only be understood in relation to the whole. This development demanded from CEREST staff a conceptual mastery much beyond the one endowed by the traditional, classic disciplines. The

expansion in time and physical space of the object is currently demanding new mediators to deal with the corresponding challenges. MAPA deals with this side of the expansion of the elements that need to be investigated. However, within such expansion in approach, a large part of the “pathological” elements of companies are not traditional CEREST objects, nor are the subjects fit agents of intervention endowed with sufficient power to promote and support organizational changes in companies by themselves (i.e., a new object for CEREST and its partner community). The expansion of the object suggests a need to also expand the community.

All the aforementioned changes are demands posed by the new object within a cycle that seems to be in its germinal stage. To consolidate the new object, CEREST staff needs to be strengthened and expanded, the autonomy of the agents needs to be reinforced and fortified, which includes the establishment of a typical state career and enlargement of the network involving the community; all of these being essential requirements to ensure the efficiency of occupational health and

safety auditing³⁷. In addition, CEREST staff analytical ability and mastery of tools and methods integrating diagnosis and intervention should be expanded and reinforced, so as to invert the role the internal actors of companies play so that they might shift from informants to protagonists (change agents). Finally, a more democratic and cooperative division of labor needs to be consolidated within CEREST staff itself, with emphasis on shared knowledge not compartmentalized in specialties.

The trajectory described in the present article might contribute to reflect on challenges beyond the sphere of local practice. Indeed, it brings elements to the debates on the need of innovation in public surveillance actions that transcend the healthcare sector.

A new object expansion mediated by formative interventions presupposes the strengthening of RENAST links, as well as of other institutions active in this field, as action and intervention targeting organizational issues also presuppose a new network design, a truly encompassing network³⁵.

Collaborations

All authors participated in the article project, development and review from design and the design proposed by RAG Vilela, which was reworked and improved in production workshop of the article. MHP Gomes and SRC Duracenko participated in the collection and organization of of documentary data. All authors contributed writing, analysis and review.

Acknowledgments

To the São Paulo Research Foundation (FAPESP) for funding Thematic Project work accidents: from socio-technical analysis to the social construction of change” and to the study team. Special thanks to Mariana Tavares Guimarães and CEREST Piracicaba staff, represented by its coordinator, Clarice Aparecida Bragantini, Alessandro José Nunes da Silva and Eclea Spiridião Bravo.

References

1. Brasil. Portaria Nº 1.823, de 23 de agosto de 2012. Institui a Política Nacional de Saúde do Trabalhador e da Trabalhadora. *Diário Oficial da União* 2012; 24 ago.
2. Vasconcellos LCF, Minayo Gomez C, Machado JMH. Entre o definido e o por fazer na Vigilância em Saúde do Trabalhador. *Cien Saude Colet* 2014; 19(12):4617-4626.
3. Brasil. Portaria nº 3.120, de 1 de julho de 1998. *Diário Oficial da União* 1998; 2 jul.
4. Costa DF, Lacaz FAC, Jackson Filho M, Vilela RAG. Saúde do Trabalhador no SUS: desafios para uma política pública. *Rev Bras Saúde Ocup* 2013; 38(127):11-30.
5. Machado JMH. A propósito da Vigilância em Saúde do Trabalhador. *Cien Saude Colet* 2005; 10(4):987-992.
6. Brasil. Ministério da Saúde (MS). 2º *Inventário da RENAST de Saúde do Trabalhador: Acompanhamento da Rede Nacional de Atenção Integral em Saúde do Trabalhador, 2010-2011*. Brasília: MS; 2012. [acessado 2016 Fev 10]. Disponível em: <http://renastonline.ensp.fiocruz.br/sites/default/files/arquivos/recursos/Inventario%20RENAST%202010-2011.pdf>
7. Baker EL. Sentinel event notification system for occupational risks – SENSOR. The concept. *Am J Public Health* 1989; 79(Supl.):18-21.
8. Vilela RAG. *Desafios da vigilância e prevenção de acidentes de trabalho*. São Paulo: LTR Editora; 2003.

9. Jackson Filho JM, Barreira THC. A construção da saúde do trabalhador em Piracicaba: análise da ação pública no período de 1998 a 2009. In: Simonelli AP, Rodrigues DS, organizadores. *Saúde do trabalho em debate: velhas questões, novas perspectivas*. Brasília: Paralelo 15; 2013. p. 357-392.
10. David HG. *Saúde do trabalhador na manchete do jornal: análise descritiva do caso do Centro de Referência em Saúde do Trabalhador (CEREST) de Piracicaba – SP* [dissertação]. São Paulo: Fundacentro; 2014.
11. Almeida IM, Vilela RAG, Silva AJN, Beltran SL. Modelo de Análise e Prevenção de Acidentes - MAPA: ferramenta para a vigilância em Saúde do trabalhador. *Cien Saude Colet* 2014; 19(12):4679-4688.
12. Vilela RAG, Almeida IM, Nunes da Silva A, Gomes MH, Prado H, Buoso E, Dias MD, Cavalcante S, Lacorte LEC. Forum: social network for the surveillance and prevention of work place accidents. *Work* 2012; 41(1):3123-3129.
13. Yin R. *Estudo de caso: planejamento e métodos*. 2ª ed. Porto Alegre: Bookman; 2001.
14. Minayo MCS. *O desafio do conhecimento. Pesquisa qualitativa em saúde*. 9ª ed. São Paulo: Hucitec; 2006.
15. Leontiev AN. *Activity. Consciousness. Personality*. Englewood Cliffs: Prentice Hall; 1978.
16. Engeström Y. *Learning by expanding: An activity-theoretical approach to developmental research*. Helsinki: Orienta-Konsultit; 1987.
17. Engeström Y. *Learning by expanding*. Cambridge: Cambridge University Press; 2014.
18. Virkkunen J, Newnham DSO. *Laboratório de Mudança: Uma ferramenta para o desenvolvimento colaborativo do trabalho e educação*. Belo Horizonte: Fabrefactum; 2015.
19. Sewell Junior WH. Historical events as transformation of structures: inventing revolution at the Bastille. *Theory and Society* 1996; 25(6):841-881.
20. Querol MAP, Jackson Filho JM, Cassandre MP. Change Laboratory: Uma Proposta Metodológica Para Pesquisa e Desenvolvimento da Aprendizagem Organizacional. *Administração: Ensino e Pesquisa* 2012; 12(4):609-640.
21. Vilela RAG, Ricardi GVF, Igutí AM. Experiência do Programa de Saúde do Trabalhador de Piracicaba: Desafios da Vigilância em Acidentes do Trabalho. *Informe Epidemiológico do SUS* 2001; 10(2):81-92.
22. Binder MCP, Monteau M, Almeida IM. *Árvore de Causas. Método de Investigação de Acidentes do Trabalho*. São Paulo: Publisher Brasil Editora; 1995.
23. Cordeiro RC, Vilela RAG, Medeiros MAT, Gonçalves CGO, Bragantini CA, Varolla AJ, Stephan C. O sistema de vigilância de acidentes do trabalho de Piracicaba, São Paulo, Brasil. *Cad Saude Publica* 2005; 21(5):1574-1583.
24. Cordeiro RC, Vilela RAG, Medeiros MAT, Gonçalves CGO, Bragantini CA, Stephan C, Varolla AJ. A System for Occupational Injury Surveillance in Piracicaba, Southeastern Brazil. *New Solutions* 2007; 17(4):363-375.
25. Vilela RAG, Machado JH. Debatedores. *Cien Saude Colet* 2011, 16(8):3369-3372.
26. Vilela RAG, Santos SA, Silva AJN, Almeida IM. Experiência de vigilância no setor canavieiro: desafios para interromper a "maratona" perigosa dos canaviais. *Cien Saude Colet* 2014; 19(12):4659-4668.
27. Lacorte LEC, Vilela RAG, Silva RC, Chiesa AM, Tulio ES, Franco RR, Bravo ES. Os nós da rede para erradicação do trabalho infanto-juvenil na produção de joias e bijuterias em Limeira - SP. *Rev Bras Saúde Ocup* 2013; 38(128):199-215.
28. Câmara Municipal de Piracicaba. Lei nº 6085, de 27 de novembro de 2007. Convênio de Cooperação entre o Município de Piracicaba e a Procuradoria Regional do Trabalho da 15ª Região para atuação conjunta em Saúde do Trabalhador. *Diário Oficial de Piracicaba* 2007; 28 nov.
29. Vilela RAG, Almeida IM, Mendes RWB. Da vigilância para prevenção de acidentes de trabalho: contribuição da ergonomia da atividade. *Cien Saude Colet* 2012; 17(10):2817-2830.
30. Medeiros MAT, Salermo VL, Silvestre MP, Magalhães LV. Política de Saúde do Trabalhador: revisitando o caso do Centro de Referência em Saúde do Trabalhador de Campinas. *Rev Bras Saúde Ocup* 2013; 38(127):81-91.
31. Assunção AA, Lima FPA. A Contribuição da Ergonomia para a Identificação, Redução e Eliminação da Nocividade do Trabalho. In: Mendes R, organizador. *A Patologia do Trabalho*. Belo Horizonte: Ed. Atheneu; 2002. p. 1767-1789.
32. Vilela RAG. Ações interinstitucionais para o diagnóstico e prevenção de acidentes do trabalho: aprimoramento de uma proposta para a Região de Piracicaba. *Relatório Final de Pesquisa em Políticas Públicas*. FAPESP, Prot. 06/51684-3, 2009.
33. Guérin F, Laville A, Daniellou F, Duraffourg J, Kerguelen A. *Compreender o trabalho para transformá-lo: a prática da ergonomia*. São Paulo: Edgard Blucher; 2001.
34. Almeida IM, Vilela RAG. *Modelo de Análise e Prevenção de Acidentes (MAPA)*. Piracicaba: Edit. CEREST Piracicaba; 2010.
35. Mendes RWB, Takahashi MABC, Cerveny GCO, Querol MAP, Vilela RAG. Change Laboratory: Formative Intervention and remodelling of the system of activity of a Centre of Reference for Worker Health in Brazil. *Proceedings book of 8th International Working on Safety Conference (WOS)*. Portugal. Lisbon; University of Minho; 2015; 1: 240-248.
36. Llory M, Montmayeul R. *O acidente e a organização*. Belo Horizonte: Fabrefactum; 2014.
37. Amengual M. Pathways to enforcement: labor inspectors leveraging linkages with society in Argentina. *Industrial and Labor Relations Review* 2014; 67(1):3-33.

Article submitted 26/04/2016

Approved 06/10/2016

Final version submitted 08/10/2016