Evaluating the Prospective Benefits of Physical Demands Description (PDD) Data Created from Job Simulations

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

A physical demands description (PDD) is a document that results from the systematic procedure to quantify, and evaluate all of the physical and environmental demand components of all essential and non- essential tasks of a job. PDDs provide important information to individuals involved in the treatment of work-related musculoskeletal disorder (WMSD). The information contained within a PDD may provide insight into what may have led to a WMSD. Research has uncovered concerns with the current methods of development related to the quality and quantity of information contained in the PDD documents (Coffey, Vandergriendt, & Fischer, 2016). Missing or low quality information contained with a PDD document may have adverse effects on the return to work (RTW) process where they are typically used as a comparison vehicle against an injured workers functional abilities (S. Isernhagen, 2006). Recent advances in digital human modeling software (Ward, Stephens, & Cort, 2015) have provided users the ability to quickly generate PDDs from digital human model (DHM) simulations of entire jobs, referred in this work as the ePDD, for electronic PDD. This development provides the possibility to overcome some of the challenges with the current methods of PDD development, as a simulation of an entire job could minimize or eliminate the possibility for missing information in the PDD if all job tasks are modeled. The objective of this investigation was to gather user thoughts, opinions, and beliefs regarding PDD use in the RTW process, and to examine thoughts on the ePDD as a tool in RTW.

Semi structured one-on-one interviews were conducted with nineteen (16) participants with professional experience facilitating the RTW of injured workers for longer than one (1) year professionally. Interviews were ninety-three minutes (93 ±29) in duration and were conducted in person or via telephone based on participant preference. Participants were provided with samples of both the traditionally developed PDDs and ePDDs prior to the interview and were asked to review the documents. Participants were asked to gather their thoughts on the use of PDD data in the RTW process

and their thoughts on the novel method of PDD development via DMH. Field notes were taken, and audio of the interview was recorded and transcribed verbatim. Transcriptions were analyzed using QSR International NVivo 12 analysis software. Transcripts were thematically analyzed by two (2) researchers following the reflexive inductive thematic analysis process outlined by Braun and Clarke (Braun & Clarke, 2006).

It was uncovered that participants believe PDDs are used primarily to serve as a comparison tool in the job match process. PDDs are used as a comparison tool to ensure a worker under typical circumstances can perform their entire preinjury duties, and to inform job modification efforts in attempts to minimize the amount of time an injured employee spends away from work. Participants also believed that PDDs or similar type documents are not consistently used in the RTW process and may be overlooked in a significant number of cases. Areas of improvement for PDDs include: improving quality of information contained within the documents, standardization of the information contained within the documents in order to increase ease of use, and attempting to align the information presented in PDDs with common information provided by healthcare providers to facilitate easy comparison. When it came to the ePDD, it was found to not be a suitable replacement for the PDDs used currently. Participants believed that the ePDD: contains a significant amount of information, were difficult to read overall, and contained information that would not be useful to professionals in the RTW process. The ePDD provides a video of the job being performed and both graphical and text presentation of relevant PDD information. It was believed that the ePDD might be harmful to the RTW process as some users may not be able to extract the required information and may become confused when using the ePDD. While the ePDD may not be a useful tool overall in RTW, there were benefits found with the ePDD, most notable the visual presentation of information. While the ePDD as a whole is believed to contain too much information and be difficult to read, the graphical nature of the presented information was believed to facilitate simple communication and potentially minimize issues gathering specific information from the document.

Improvements to current PDD documents should be focused on addressing concerns related to what information the documents present, how the documents present that information, and how that information may or may not be used in current RTW practice. The ePDD is not a suitable replacement for current PDD documents in RTW, however could serve as a useful addition, providing visual information lacking in typical PDDs. Future work related to the use of PDDs in RTW should gather information from other groups relevant in RTW who may use or interact with PDDs, such as but not limited to health care practitioners, disability insurance professionals, worker advocates such as union representatives and workers who have been through the RTW process.

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Without the assistance of everyone I have mentioned above, and those I have forgot to mention, I would not be where I am today. I thank you all for the contributions you have made in my life.

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List of Acronyms

ACE –Association for Canadian Ergonomists

DHM - Digital human modeling

ePDD – Electronic physical demands description

FAE – Functional abilities evaluation

FCE – Functional capacity evaluations

HCP – Health care provider

ISO - International Organization for Standardization

MSD – Musculoskeletal disorder

NOC - National Occupational Classification

OHCOW – Occupational Health Clinics for Ontario Workers

OHRC – Ontario Human Rights Commission

OKA – Ontario Kinesiology Association

PDD – Physical demands description

PDA – Physical demands analysis

RTW – Return to work

TS – Technical Specification

TSB – Task Simulation Builder (component of the Tecnomatix Jack software developed by Siemens)

WMSD – Work-related musculoskeletal disorder

WSIB – Workplace Safety and Insurance Board (of Ontario)

Introduction

A physical demands description (PDD) is the document that results from the systematic procedure to quantify, and evaluate all of the physical and environmental demand components of all essential and non- essential tasks of a job (Occupational Health Clinics for Ontario Workers, 2014a). PDDs provide important information to anyone involved in the treatment of individuals suffering from a physical ailment such as work-related musculoskeletal disorder (WMSD). WMSDs consist of a range of inflammatory and degenerative conditions typically affecting the low back, neck, shoulders, forearms and hands (Punnett & Wegman, 2004). WMSDs are multifactorial diseases which stem from workers' exposure to hazards pertaining to the physical, psychosocial, and organizational environment (David, 2005). Approximately 40% of workplace injuries severe enough to require the employee to take time away from work to recover are the result of WMSDs (Punnett & Wegman, 2004). The information contained within a PDD provides insight into what may have led to an injury, and also provide information regarding what an individual is required to be able to physically tolerate in order to return to work. As such, any issues or inaccuracies with the data contained within a PDD may prove detrimental to the process of returning an injured employee back to work.

Employers should be motivated to minimize and control ergonomic hazard exposure within the workplace, and should also facilitate early and safe return-to-work (RTW) following injury (D. Isernhagen, 2000). One model proposed to facilitate effective job design and the safe return of workers to the workplace is the Job (function) matching model (Armstrong et al., 2001; S. Isernhagen, 2006). In this model (Figure 1) it is important to quantify the capabilities of the worker (S. Isernhagen, 2000) and the demands required to perform the job, such that workers can be appropriately matched to a job based on their capabilities (Pransky, Shaw, Franche, & Clarke, 2004). Within the Province of Ontario, the job matching model is used in order to facilitate the reintegration of injured workers into the workforce. See Figure 1 below for a graphical representation of the process.

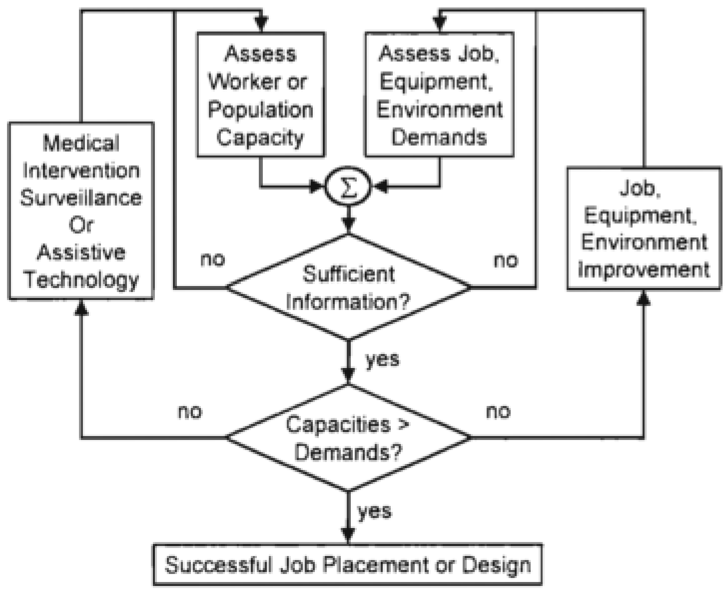

Figure 1. from (Armstrong et al., 2001). Generic model of matching worker capabilities to job demands for job placement

Return to Work in the Province of Ontario

Within the Province of Ontario, WMSDs qualify as a disability (Ontario Human Rights Commission, 2008), it is legislated that employers must provide accommodations to workers living with disabilities (Ontario Human Rights Commission, 2009). According to the Ontario Human Rights Commission (OHRC), if it is possible to reintegrate an injured worker into the workplace, the process involves accommodating the worker in their current capacity, in a non-discriminatory fashion. In order to do so, the employer must determine the workers current capacity to perform work, then find a way of utilizing the worker in meaningful work which matches their capacity, and maintains the worker's dignity.

According to the Supreme Court of Canada, each case must be individually examined and a three step process must be under taken in order to accommodate individuals in the workplace, this process consists of individuals being “considered, assessed, and accommodated” (Ontario Human Rights Commission, 2009). The employee must be considered for employment, their capacity to perform work must be assessed, and they must be accommodated in the workplace if possible. However, employers are not required to accommodate all individuals, only those which would not place the employer under “undue hardship”(Ontario Human Rights Commission, 2008). Undue hardship entails any changes to the workplace that would be unreasonably difficult to perform based upon health, safety, and financial means (Canadian Human Rights Commission, 2007).

Using the conceptual model (Figure 1) as a framework, the process of “considering, assessing, and accommodating” can be achieved by first assessing the capacity of the worker and the demands of the job. To assess capacity we use functional capacity evaluations (FCE), also known as a functional abilities evaluation (FAE) (Cronin et al., 2013). To assess demands, a PDD is performed (Occupational Health Clinics for Ontario Workers, 2014b). As illustrated in the model, these sources of information can be compared and contrasted to determine job fit or to indicate where accommodation may be required. Accommodations may include modification to job duties or to job design. In the event that job duties or design cannot accommodate the returning employee the worker may be assigned to a different job that is more appropriately matched to their current capacity.

Limitations of the Current Job Matching Process

The job match process is not without it its challenges and is not always a possibility given the type of work performed and the capabilities of the worker at the time of work offer provision. In some circumstances it is not possible for an employer to be able to provide their worker with suitable modified work as it would place the employer in a position of “undue hardship” (Ontario Human Rights Commission, 2008), as accommodating the worker could place either the worker or the employer at unreasonable risks based on health, safety, or financial considerations surrounding the situation where accommodation is required. When job match is possible the process is not without limitation. Lack of information regarding the physical demands of a job (Canadian Medical Association, 2013), lack of information about the availability of modified work (Duijn, Miedema, Elders, & Burdorf, 2004), and the inappropriate selection of modified work (MacEachen, Clarke, Franche, & Irvin, 2006) remain as three significant barriers to facilitating the successful, early, and safe return to work for injured employees. These barriers all appear to stem from breakdowns in communication between some or all of the parties (stakeholders) involved in this complex process.

It is not surprising that effective communication, that is both comprehensive and timely (Iles & Wyatt, 2013), has been noted as beneficial to the RTW process. Ineffective communication does not allow the stakeholders involved in the process to coordinate their resources (Ståhl, Svensson, Petersson, & Ekberg, 2010). The more information that is conveyed between the members of the RTW process, the faster the process is able to return the injured individual to work (Anema, J., Van Der Giezen, A., Buijs, P., & Van Mechelen, 2002). Effective communication allows stakeholders to make more effective decisions as they are not waiting on critical information in order to make an informed decision (Liukko & Kuuva, 2017), or possibly forced to make a decision based upon incomplete information. A lack of effective communication between stakeholders may limit the ability to share complex concepts amongst the stakeholders involved (Ståhl, Svensson, & Ekberg, 2011). For example a misunderstanding between a RTW coordinator and an individual within a human resource department attempting to find suitable accommodation for an individual with a WMSD may likely hinder the RTW process as both individuals do not share a similar frame of reference (Martin, Nielsen, Petersen, Jakobsen, & Rugulies, 2012) with regards to the injury in question. As a possible solution to issues regarding the lack of information of the physical demands of the job it would be beneficial to examine how the physical demands of a job are currently quantified and identify areas of improvement.

The Current Approach to Physical Demands Descriptions

A four-step process is applied to generate a PDD. The assessor completing the PDD must: 1) determine the job purpose and tasks, 2) observe the job to verify job purpose and tasks, 3) quantify the physical demands, and, 4) classify essential and non-essential duties of the job (Occupational Health Clinics for Ontario Workers, 2014b). As recommended by the Occupational Health Clinics for Ontario Workers (OHCOW) handbook, the individual performing the assessment should either be a skilled ergonomics professional, or at least be trained in ergonomic assessment methods (Occupational Health Clinics for Ontario Workers, 2014b). However, PDDs are most often conducted by individuals with limited education and/or experience in ergonomics or specifically in the measurement and assessment of physical demands (Coffey, Vandergriendt, et al., 2016). Less experienced observers have been shown to be able to correctly classify <90% physical demand elements (Robertson et al., 2009), they may miss relevant job components entirely, and may inaccurately measure forces when quantifying job demands (Coffey, Vandergriendt, et al., 2016). This body of evidence suggests that the quality of the information contained within a PDD, may not be accurate. The potential reduction in the quality of the information may call into question the usefulness of a PDD created by a novice assessor. To compound these issues, there is no accepted standard with regards to the reporting of PDD data. This leaves end users of PDDs with the challenge of possibly having to interpret multiple different structures and formats of PDDs, each developed in its own specific manner with the accompanying differences in data structure, in order to perform their required duties.

Utilizing Digital Technologies to Overcome Issues Related to Traditional PDDs

Advances in digital human modeling (DHM) software capabilities may offer a new means of generating and describing physical demands description data. DHMs permit proactive identification of ergonomic related concerns, potentially reducing the numbers of worker that end up in the RTW process in the first place. In addition, PDD data generated by DHM may provide the user with enhanced opportunities to visualize the job in question without the requirement to be physically present at the work location. DHM software packages allow a user to create virtual environments, complete with intractable elements, where a human manikin can simulate interaction within the workplace. These software packages have been developed, and used historically in order to increase the level of quality of the ergonomic design process (Mazzola, Forzoni, D ’onofrio, & Andreoni, 2016), design suitability, and to increase the speed of product development (Tian & Duffy, 2011). DHM tools allow users to test out potential designs, and obtain the feedback necessary to make the required changes quickly. The virtual environments created within the DHM tools allow the user to not only perform mathematical analyses of the tasks (Harih & Dolšak, 2013) but also provides the user with valuable visual information (Demirel & Duffy, 2007). The enhanced visual information may help address existing barriers regarding the quality of information contained in a traditional PDD. The use of DHMs to develop PDDs from a previously developed simulation would increase the overall value of the DMH. Developing a PDD from a theoretical, proactive ergonomic analysis during the design stage of a workstation could minimize the measurement error that may occur while attempting to measure live processes, as relevant information should be know when designing a workstation.

In order to use a DHM tools to model a task, job, or process, the user requires the same objective information as is required to develop a PDD i.e. heights, reaches, etc. DHMs require objective information in order to ensure that the simulation realistically represents the job. As a PDD and DHM simulation share the many of the same inputs, a DHM simulation could be used to develop a PDD. Since a computer simulation contains much more information about a job that a traditional PDD, a DHM-based PDD or electronic PDD (ePDD) should provide richer, more detailed informational content compared to a traditionally developed PDD.

Recent work has explored the development of an ePDD using simulations. Ward and colleagues (Ward et al., 2015) developed DHM simulations of 20 jobs and then worked with the DHM manufacturer (Siemens PLM Software, Plano, Texas, USA) to use the emerging data from digital job simulations to create an ePDD of those jobs. One of the findings from this work was the identification that the DHM simulation video could supplement the PDD document. In a traditional PDD, video may be challenging due to ethical and privacy consideration (Mckinnon, Callaghan, & Dickerson, 2011; Paquet, Mathiassen, & Dempsey, 2006). However, when a DHM manikin is used in a video of a simulation, ethical and privacy considerations related to the collection, storage and use of potentially sensitive information are overcome. Within a digital simulation only the information that is intended to be conveyed is presented to the audience. Sensitive information such as that which may identify the worker, and proprietary business information such as designs of tooling/machinery/the factory are not presented to the viewer of the simulation, unless specifically required to describe the task in question. During the development of a PDD, information that an employer may deem sensitive, such as the equipment surrounding a workstation may be captured in a video or a picture of the job task. Using a digital simulation, if the sensitive information it is not relevant to the task being assessed, it is possible to not include or quickly remove that information from the report/output. Worker privacy is protected with the use of a DHM as no information that could directly identify the worker, e.g. images of face/body, is presented in the outputs of a simulation. The generated video could allow anyone, not just a user with access to DHM software, to visualize the job and associated physical requirements given access to basic digital tools such as a computer, tablet, or smartphone. Ward notes that the addition of a video could afford end users with greater context to frame the quantitative information contained within the PDD. However, the idea of the ePDD remains in its infancy, and we do not yet know if RTW professionals, who use PDD information to make decisions within the job-match context, will see added value in such videos or moreover in the concept of an ePDD generated from a DHM simulation.

Purpose

The main focus of this investigation was three-fold;

1. Understand how RTW professionals, and ergonomists (end users) utilize a PDD in their role in order to facilitate the RTW process

2. Uncover end user attitudes, beliefs and perceptions related to the utility of traditional PDD data to inform decisions within the RTW process

3. Uncover end user attitudes and perceptions regarding the perceived strengths and limitations of using an ePDD developed through the use of a digital simulation within the RTW process

For this investigation, sample PDDs and ePDDs were used as an information source to inform participant discussion. Sample PDDs and ePDDs described real jobs existing at The Ford Motor Company of Canada's Oakville Assembly Complex were used. The digital human modeling software package "Tecnomatix Jack 8.4" was used to create digital simulations of twenty (20) real assembly line jobs at the Oakville Assembly Complex. These simulations were used to create ePDDs and associated videos for each job. Using semi-structured one-on-one interviews, end users were encouraged to discuss their beliefs and perceptions regarding the role of PDD data within the job-match process, and were further asked to share their perceptions on the utility of ePDDs, relative to traditional PDD data. In order to inform the discussion participants were provided with samples of PDDs and ePDDs from five (5) jobs out of the collection of twenty (20). The three main research questions investigated in this thesis include:

1. How are PDDs used in RTW?
2. Are their any shortcomings of PDDs as it relates to their use in current RTW practice?

3. Does the novel approach of PDDs derived from a digital simulation (ePDD) address any perceived shortcomings of traditional PDDs in the RTW process, and how may this tool be used in current RTW practice?

Literature Review

Musculoskeletal Disorders

Musculoskeletal disorders (MSDs) include range of inflammatory and degenerative conditions that may affect tissues throughout of the body. These disorders can have a substantial impact on an individual's long term quality of life and may also cause substantial economic burdens (Punnett & Wegman, 2004; Solidaki et al., 2010). MSDs have been linked to workplace factors since the 18th century (Ramazzini, 2001); however only recently have more concrete links emerged between exposure to ergonomic hazards and the likelihood of MSD development (Bernard, 1997). MSDs which are caused or aggravated by an individual's occupational activity are referred to as "work related musculoskeletal disorders" (WMSDs) (Costa & Vieira, 2010). WMSDs most commonly affect the low back, neck, shoulders, forearms and hands (Punnett & Wegman, 2004). Details of the prevalence of WMSDs suggests that 20-30% of individuals experience some upper extremity WMSD (Punnett & Wegman, 2004).

WMSD Risk Factors

The etiology of these disorders is complex encompassing biomechanical, individual, psychosocial, and organisational risk factors (S. S. Bao et al., 2016). For this review, biomechanical factors will be the main focus with respect to the discussion of WMSDs.

Biomechanical WMSD Risk Factors

Biomechanical risk factors affect the target tissues directly at a structural level. Identified biomechanical risk factors for WMSDs include the following; repetitiveness, available recovery time, physical workload, static efforts, non-neutral body postures, mechanical compression of tissues, segmental or whole-body vibration (Burdorf, 2010; Costa & Vieira, 2010; Hembecker, Reis, Konrath, Gontijo, & Merino, 2017; Rosecrance & Cook, 2010). The link between risk factor exposure and incidence of WMSDs is nonlinear (Costa & Vieira, 2010). Research shows that although reducing occupational exposure to risk factors does have a positive effect, the causal link between exposure and incidence needs to be better understood with further research (Dempsey, 2007; Van Eerd, Munhall, Irvin, Rempel, Brewer, van der Beek, et al., 2016). Reductions in risk factor exposure and a 1:1 reduction in injury rates rarely exist, and many factors show a plateau effect below certain exposure levels. Tissue level experimentation may provide information related to the mechanical nature of WMSDs. However, the complex interactions that occur outside of a laboratory environment related to possible occupational and non-occupational risk factors (i.e. house work, leisure time activities, sleep status, etc.), are challenging to measure. It is not currently possible to determine where the impact of the direct occupational exposures ends and the interacting non-occupational factors begins given the current state of epidemiologic research on WMSDs (Punnett & Wegman, 2004).

Costs of WMSDs

WMSD pose significant socio-economic costs to workers, employers, and society as a whole. One of the main socio-economic impacts of WMSDs are the number of days of work lost to these disorders. WMSDs lead to the greatest amount of work absenteeism or disability in the United States, Canada, Finland, Sweden, and England (Punnett & Wegman, 2004). Many of the direct compensation costs related to the treatment and absenteeism (Maiwald, De Rijk, Guzman, Schonstein, & Yassi, 2011) are incurred by the employer (Rosecrance & Cook, 2010). Other indirect economic factors incurred by employers include early worker exit from the labour market, and reduced worker productivity (Yan et al., 2017). There are costs related to WMSDs which are externalized from the workers compensation system, these are costs borne upon the worker. Monetary costs for out of pocket expenses related to the WMSD (Morse, Dillon, Warren, Levenstein, & Warren, 1994) such as the cost of traveling to medical appointments, and other supplementary costs that add up over time are a common issue for injured workers that may not be compensated by insurers or employers. Other more significant, non-economic, costs which the injured worker incurs include increased occupational morbidity (S. S. Bao et al., 2016) and the long term loss of quality of life (Bae & Min, 2016; Trask, 2013). With the rising costs of workers compensation (Baril, Clarke, Friesen, Stock, & Cole, 2003), and an aging workforce (T. Sullivan, 2000), there are economic incentives not only for employers, but societies as well, to minimize the negative effects WMSD risk factors pose to their workforce. Minimization of healthcare expenses is one way in which the business case for MSD prevention may be made, another is the growing body of literature linking successful ergonomic practices, which minimize WMSD risk, to increases in work productivity (Neumann & Village, 2012; Thun, Lehr, & Bierwirth, 2011).

WMSD Prevention Strategies

Prevention strategies for WMSDs fall into three categories, primary, secondary, and tertiary strategies. Primary prevention strategies focus on ergonomic interventions which aim to minimize the exposure to WMSD risk factors or to prevent exposures altogether (Burdorf, 2010; Silverstein & Clark, 2004) or minimizing the impact of the exposures. Secondary prevention strategies aim to avoid worsening the injury, reducing time lost, and supporting the return-to-work (RTW) process in a manner which attempts to minimize the long term effects of the employee's injury and maximize their productivity in the workplace (Maiwald et al., 2011; M. J. L. Sullivan et al., 2005; Womack & Armstrong, 2005). Tertiary prevention strategies focus on facilitating a RTW or maintaining productivity of individuals who suffer from chronic disability (Roquelaure, 2016). It is the intention that these three approaches to WMSD prevention are applied as required in order to minimize WMSD risk factors, and if required, minimize/eliminate any barriers affecting a worker dealing with WMSDs such that the worker returns to work as soon as realistically possible (D. Isernhagen, 2000).

Primary Prevention

Primary WMSD prevention strategies aim to reduce the loads placed upon the worker. These strategies have been noted by the International Organization for Standardization (ISO) as a means of reducing the ergonomic risks of performing work. This is noted in the Technical Specification (TS), ISO/TS 20646-1 "Ergonomic procedures for the improvement of local muscular workloads (LMWL)--Part 1 (Ebara et al., 2007). These strategies work under the assumption that the load endured by the workers exceeds their capacity, and should be reduced and/or eliminated in order to ensure workers do not overexert themselves. Drawing a parallel to the field of athletic performance, this TS suggests that workers being placed into situations in which they are subject to high or excessive loads upon the body, as noted in Figure 2, are at an increased risk of injury. This TS states that a reduction of loads placed upon the body would reduce the workers risk of injury, as the total loading of the body would move from the high/excessive regions towards that of an optimal load. Examples of these strategies include the utilization of mechanised equipment such as a lift assist during a manual material handling task, the redesign of a workstation to eliminate trunk flexion during a lift, or the complete elimination of a lift via the use of an overhead crane. Further drawing parallels from the field of athletic performance, primary prevention strategies may also be performed in order to increase the workers capacity for work and minimize the impact of biomechanical stress. Research has shown potential improvements WMSD prevalence with workers who perform strength training and physical exercise programs (Krüger et al., 2015; Serra, Camargo, Zaia, Tonello, & Quemelo, 2018; Van Eerd, Munhall, Irvin, Rempel, Brewer, Van Der Beek, et al., 2016).

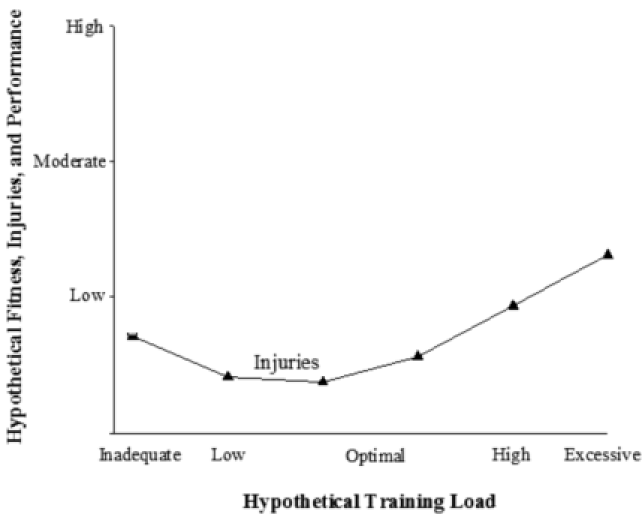

Figure 2. Hypothetical Load vs Injury. Adapted from (Gabbett, 2017)

Secondary Prevention

Secondary WMSD prevention strategies aim to treat injury early, stop the progression of current injuries, prevent further disability and re-injury, and ultimately return the worker to full health (M. J. L. Sullivan et al., 2005). These strategies rely on providing the worker with tasks in which they are capable of performing, however will not exceed their current capacity to perform work. Examples would include the modification of job tasks, or the availability of new available jobs that match worker capacity (Institute for Work and Health, 2015), use of personal protective equipment, further worker training (Womack & Armstrong, 2005) and a reduction in psychosocial risk factors. Secondary prevention strategies potentially include both administrative and engineering controls with the intent of modifying loads, both physical and cognitive, placed upon the worker.

Tertiary Prevention

Tertiary prevention strategies begin once the injured worker has made their maximum recovery. If a tertiary prevention strategy is being utilized, a worker has not recovered to their pre-injury status, but has completed their recovery to the maximum of their capability. Tertiary prevention efforts typically include strategies such as vocational rehabilitation in order to best utilize the remaining capacity of a worker once they have reached "maximal" recovery (Institute for Work and Health, 2015; Pransky et al., 2004). The vocational rehabilitation programs focus primarily on counselling the individual who now suffers from a permanent impairment, as well as providing retraining such that the individual is able to productively contribute to the workforce in a position better suited to their work capacity.

Combining Strategies to Form an Effective Prevention Program

These three categories of WMSD prevention strategies, when combined, should increase the overall efficacy of the prevention efforts (Roquelaure, 2016). Each category address issues differently in order to tailor the efforts in a manner that will have the greatest effect for a given scenario. However, as these processes do not occur in a vacuum, solutions generated in one stage of the process may influence earlier or later stages in the future. For example, a tertiary ergonomic solution may address the issues noted with an injured worker, worker while also impacting, and providing a potential benefit, for a co-worker sharing the same workstation, thereby providing a tertiary and primary preventative effect (Krause, Dasinger, & Neuhauser, 1998).

Secondary Prevention Strategies and the Return to Work Process

While research and practice should continue to support primary prevention, it remains equally important to consider secondary prevention, and more specifically, RTW. Employers have begun to recognize the benefits of workplace changes that facilitate the RTW process (Canadian Medical Association, 2013). The main financial benefits of a successful RTW process include reductions in medical (Iles & Wyatt, 2013) and insurance costs (Maiwald, Meershoek, Rijk, & Nijhuis, 2013; Schandelmaier et al., 2012). Direct workplace benefits include: increases in productivity (Bae & Min, 2016; Baldwin, 2004), shorter injury duration (McLaren, Reville, & Seabury, 2017), and a higher likelihood for employee return to the workplace (M. J. L. Sullivan et al., 2005). RTW interventions have been shown to provide a direct benefit to the injured worker with, positive physical and mental health implications (Bart Staal, De Rijk, Houkes, & Heymans, 2013), fewer days away from the workplace (W. S. Shaw, Robertson, Pransky, & Mclellan, 2003) while enhancing the overall recovery process (MacEachen, Ferrier, Kosny, & Chambers, 2007). With the wide range of benefits that result from a successful RTW process, many of which can lead to greater overall profitability, it is in the employers' best interest for the return to work process to be as safe, efficient and effective as possible.

The RTW process involves multiple parties, each attempting to facilitate the return of the injured employee. Who is involved in the process varies greatly (J. B. C. James, Guest, & Rivett, 2015). In addition to the injured employee, Individuals involved in the process may include: employer representatives, insurance representatives, independent case managers, physicians, physical therapists, occupational therapists, nurses, kinesiologists, ergonomists, as well as other individuals with skillsets that may facilitate the mitigation of injuries and reintroduction to the workplace(Beach, Ikezawa, Battie, & Gross, 2010). During the RTW process these stakeholders all interact with the specific goal of returning the injured individual to the workplace and reducing the burden to the injured individual (W. Shaw, Hong, & Pransky, 2008). One drawback of such a system in which individuals vary greatly with regards to their speciality is that each individual may not have access to, or be able to utilize, all available information provided (Canadian Medical Association, 2013). A benefit to such a system is that individual stakeholders approach the data available to them from different perspectives (Cronin et al., 2013). This provides multiple points of view to assess a problem, and potentially multiple solutions. Unfortunately, this may also lead to misunderstandings and confusion between individuals, which may lead to suboptimal decision making. In an effort to minimize any potential downsides to such a multidisciplinary approach, one individual is usually assigned to oversee the process. This individual is typically given the title of "case manager" or "return to work coordinator" (W. Shaw et al., 2008).

Limitations with Current Disability Management and the Return to Work Process

The multi-faceted and complex RTW process has its limitations. Research examining the utility and efficacy of return to work programs from around the world share many of the same recurring themes (Dasinger, Krause, Thompson, Brand, & Rudolph, 2001; Dias et al., 2019; Franche et al., 2005). Two of the major themes that arise are the requirement for clear communication between all parties, and the desire for more information. The "missing" information may relate to the status and capabilities of the injured employee, or the demands and requirements of the job they were performing during their injury or the job(s) they are able to perform during their recovery. Although having an individual dedicated to acting as a "case manager" or "return to work coordinator" has been shown to have a positive effect on the RTW process (Schandelmaier et al., 2012), that individual is only able to act upon the information which has been communicated to them from the other parties involved in the process. Thus, such gaps in knowledge, or the inability to utilize the knowledge currently known will have a detrimental effect on RTW outcomes.

Effective Communication

Effective communication is required for any process involving multiple individuals to succeed. RTW is no different. In a RTW context ineffective communication between parties can lead to detrimental treatment outcomes (Colombini & Occhipinti, 2006; MacEachen et al., 2007), whereas effective communication has been explicitly cited as being beneficial to the RTW process (Canadian Medical Association, 2013; J. B. C. James et al., 2015; Norris, 2015; W. Shaw et al., 2008). Communication breakdowns lead to the inability to translate relevant knowledge into actionable ideas (Rothmore et al., 2017). In order to promote clear and meaningful communication, access to consistent, clear, and concise sources of information about the worker/workplace could benefit all stakeholders and reduce chances for miscommunications.

Lack of Knowledge Available

The overall lack of information available has been noted as a limitation (Roberts-Yates, 2003) in the RTW process. Insufficient information regarding both the injured worker and the working environment lead to poor treatment decisions. Specifically, poor information regarding the individuals pre-injury job demands have been cited as a major concern (Baril et al., 2003; Canadian Medical Association, 2013; S. Isernhagen, 2006; Schreuder, Roelen, Boer, Brouwer, & Groothoff, 2012; W. Shaw et al., 2008). This may be due to the overall lack of quantification of the demands of the job or from the lack of clear understanding regarding what the jobs demands are from the available information.

Inaccuracies in any data used are not only limited to impacting that specific component of the RTW process. For example, inaccurate information regarding the job demands may affect the workers FCE scoring (S. Isernhagen, 2006), potentially leading to suboptimal treatment decisions. In situations like this, the effect of errors may compound throughout the process, as decisions are made based upon available information. An example would be a mis-measured weight of an object the employee is required to manipulate during their work task, if the object is measured inaccurately it could lead to the decision where the employees FCE determines they are capable to RTW without modification, and this could put the worker at a risk for re-injury. If a sample object is mis-measured and that is what stops the worker from returning to their job as modification is not possible, this could prolong the RTW process as the worker has now been inaccurately excluded from the workplace. This compounding of errors may lead to complications in the RTW process as multiple parties believe they have accurately assessed their part of the case, thus there would be no indication that something in the process requires a review to double-check the accuracy of the results.

Availability of accurate information regarding potential modified work options is also a common barrier to effective RTW (Canadian Medical Association, 2013). The lack of accurate information regarding potential modified work limits a worker’s potential to return to the job. In the job matching model, the ability of RTW coordinators and the allied health professionals treating the worker in clearing an individual to return to work is dependent on ensuring a match between the demands of the job and the capacity of the worker (Baril et al., 2003; Duijn et al., 2004). Inaccurate information with regards to both the worker and the workplace lead to inaccurate results. As noted previously, if job demand information was available for possible modified duties available to the worker, the FCE completed on the worker may determine they were able to successfully return to work in some capacity. However, as this information is usually not readily available, the RTW coordinator and associated allied health professionals have no choice but to deem the worker unfit to return. Other investigations have found a common occurrence during the RTW process to be less than ideal implementations of ergonomic modifications (Dempsey, 2007). These changes are intended to assist the worker in successfully completing their job, however, less than ideally implemented changes may lead to a reoccurrence of the previous injury or the development of a new one (MacEachen et al., 2006). The availability of a consistent, clear, and concise source of job demand information would ensure that some of these issues were alleviated, and individuals working within the RTW framework were able to successfully perform their job to the best of their abilities.

The Job Match Process - Objective Quantification of the Employee and the Work Environment

In order to safely return to the workforce an injured worker's capacity to perform work must be greater than the physical demands of the job they will perform. In the Province of Ontario, the process of employee and work environment quantification must be performed in accordance with the Ontario Human Rights Code (OHRC) (Ontario Human Rights Commission, 2008). The OHRC states that the processes of quantification used to assess the employee's physical capabilities must be non-discriminatory reasonable and “bona fide” to be reliable indicators of job performance. In order to assess the physical requirements of a job, the assessment must quantify and evaluate all of the physical and environmental components of all essential and non-essential tasks of a job. As such, the process is able to quantify what is, and is not a reasonable and “bona fide” occupational requirement (Ontario Human Rights Commission, 2008). When both the employee capabilities and the physical demands of the job have been objectively quantified it is possible to “match” the worker to the job. This matching process is performed in order to ensure the employee is not overburdened by the requirements of the job, are able to perform the required work safely, and in a manner that will not aggravate any pre-existing injury, or potentially induce a new injury (Armstrong et al., 2001; S. Isernhagen, 2006; Pransky & Dempsey, 2004; Womack & Armstrong, 2005).

Assessing the Employee

The non-discriminatory systematic analysis in which employees physical capacities are assessed with the intention of determining occupational performance is known as a Functional Capacity Evaluation (FCE), or Functional Abilities Evaluation (FAE) (C. L. James, Reneman, & Gross, 2016; Pransky & Dempsey, 2004). FCEs are conducted by qualified professionals, and consist of tests designed to assess a variety of the subject’s (employee) abilities to perform a series of task designed to replicate occupational requirements within the workplace. FCEs are backed by scientific evidence regarding the validity of the results translating to workplace performance (K. E. Sinden, Mcgillivary, Chapman, & Fischer, 2017; Haije Wind, Gouttebarge, Kuijer, Sluiter, & Frings-dresen, 2009; Hajie Wind, Gouttenbarge, Kuijer, Sluiter, & Frings-Dresen, 2006). FCEs provide the employer with the knowledge regarding the employee’s capacity necessary to match job demands in order to provide safe, meaningful employment.

Assessing the Physical Demands of the Job – Conducting a PDD

A physical demands description (PDD) is a resource detailing the physical components of a job. From an Ontario Human Rights Code perspective, the PDD must identify essential and non-essential job tasks and must objectively describe physical requirements (Ontario Human Rights Commission, 2008). Essential tasks are defined as tasks in that are core job functions. As an example, the ability to lift a 25 kg box may be a core job function for a delivery driver who is responsible for delivering packages to customers, where 25 kg was the maximum weight that the company would ship in a single package for home delivery. If the delivery driver was unable to lift 25 kg, and therefore unable to deliver the package to the customer, they would be unable to complete the core requirement of their job. Non-essential tasks are defined as tasks in which the individual performing the job may perform but are not vital to the core purpose of the job. For example, a salesperson is required to have knowledge about in-store products, and should be able to inform customers on the benefits of the product, however it is not essential that the salesperson be physically capable of lifting the product boxes to/from high shelves (Ontario Human Rights Commission, 2008).

Physical demands descriptions should include information specific to physically demanding job elements. This information includes: lifts/lowers, carries, pushes/pulls, reaches, grips/finger use, balance and sensory requirements. Specific data regarding these job elements include items such as, but not limited to: forces and weights, distances, durations, and descriptions of items manipulated (Occupational Health Clinics for Ontario Workers, 2014b). In order to quantify these job demands, typically three main types of data collection are used: direct measure, observation, and subjective worker judgements about the job (Li & Buckle, 1999; Trask, Mathiassen, Wahlström, & Forsman, 2014). An example of a direct objective measure would be the use of a scale to measure the weight of a box, or a tape measure to determine the height of a shelf (David, 2005). Observational measurements would include items such as the posture the worker utilizes while performing a task (Dartt et al., 2009).

Subjective measures would include items such as judgements regarding the balance requirements of a task, comfort, and usability (Annett, 2002). When direct measure is combined with observational and subjective information the assessor can provide a better assessment of the physical requirements of a job (van der Beek & Frings-Dresen, 1998) than either method on its own.

Concerns with the Traditional Process of PDD Creation

As long as a PDD includes a list of physical requirement descriptions, categorized as essential and non-essential, the PDD meets legal requirements. However, there are many ways to categorize and quantify demands such that there is no clear standard for presenting PDD data. The variability of inclusion and presentation of PDD data has provided some challenges, especially regarding occupations in which the job tasks are not standardized, or highly variable, such as military personnel (Wilkinson, Rayson, & Bilzon, 2008), paramedics (Coffey, Macphee, Socha, & Fischer, 2016), firefighters (K. Sinden & Macdermid, 2014), police officers (Mckinnon et al., 2011), farmers (Trask, 2013) and service staff (Jones, Strickfaden, & Kumar, 2005). This body of research has shown that this lack of standardization can lead to some issue with PDD creation.

One of the concerning issues with the process of PDD generation is the impact the of competency of the assessor has on the collected data. Research into PDD creation has shown that the typical PDD assessor is not an individual who would be considered an ergonomic expert, and as such may not correctly identify all necessary components of a PDD (Coffey, Vandergriendt, et al., 2016). This is of concern as research has shown that trained novices only have the ability to correctly identify ergonomic concerns approximately 79-90% of the time compared to an experienced ergonomic assessor (Coffey, Vandergriendt, et al., 2016; King, 1997; Robertson et al., 2009). Coffey also noted that novices, trained in the methods of developing a PDD, were able to correctly identify physical demands relevant to a PDD about 80% of the time, however, were unable to accurately quantify measures related the physical demands of a job task, such as horizontal reach, and push distances. With that being said, ergonomic training does have some positive effect on observational performance (Fethke, Merlino, & Gerr, 2013). Other research has noted contention regarding the level of detail required within the report when assessing physical demands (Jones et al., 2005). The differences in task observation may not only have an effect on documented postures, but critical hand forces as well. As Bao (S. Bao, Spielholz, Howard, & Silverstein, 2009) noted, hand postures affect force production and force production capability. Thus, the inability of a novice to correctly identify postures may lead to a misinterpretation of hand force during a critical task, further reducing the validity of the assessment. To add to the concerns with the capture of relevant job demands data, Janowitz (Janowitz et al., 2006) has noted there can be some of the difficulty in capturing and describing “unusual” and “difficult to describe” job tasks. The use of tools such as video and direct measurement devices, i.e. force gauges, may impact how the work is performed during collection, or may not be possible to use for a given job task, and may lead to inaccurate information being collected and used in the RTW process. Inaccurate/missing information contained within a PDD document may also lead to delays and undesirable outcomes in RTW. Injured workers may be incorrectly labeled as “unable to return to work” or may be placed into work that further aggravates their condition given inaccuracies in a PDD (Reynolds, Wagner, & Harder, 2006). Decisions related to the suitability of a given injury may be affected by (inaccurate/incomplete) information provided within a PDD. Decisions related to the approval of treatment or receipt of injury related benefits(Krueger, 1990) may be delayed/denied due to information contained within the PDD. If PDD information states that the work is suitable, and recovery is delayed due to inappropriate selection of work, other decisions within the broader RTW process may be impacted by PDD information, such as those made by decision makers as they relate to the injured worker’s RTW process compliance and ongoing receipt of disability benefits (S. Isernhagen, 2010). Diversity in the details and format of the PDD, along with the relationship between assessor skill and accuracy, may explain why a lack of job demand information continues to emerge as a barrier within the RTW process (Baril et al., 2003; Canadian Medical Association, 2013; S. Isernhagen, 2006; Schreuder et al., 2012; W. Shaw et al., 2008).

Utilizing Digital Human Modeling Tools to Create Physical Demands Descriptions

What are Digital Human Modeling Tools

Digital human modeling (DHM) packages are software tools which allow users to construct a virtual environment (Duffy, 2013) in which manikins interact with objects in a human like manner. These manikins possess joints with specified ranges of motion, degrees of freedom, strengths, etc. representing the movements and capabilities of a real human (Abdel-malek et al., 2008). DHM software allows for the quantification of a many of different physical variables such as heights, reaches, distances, physical fit/obstructions, and lines of sight. Some available measures are not possible or practical to obtain during a field collection, such as internal joint forces (DiLudovico et al., 2016) and metabolic energy expenditure (Yang et al., 2007). The usability and validity of these tools has improved with the development of features, such as realistic posture prediction (Reed, Faraway, Chaffin, & Martin, 2006; Zhou, Armstrong, Reed, Hoffman, & Wegner, 2009), as well as improving the biological validity and the analytical power of the simulations, and overall ease of use (Badler, 1997). With the application of DHM's, virtually all of the desired ergonomic data can be simulated and analyzed in real time without the need to interrupt a facility's production capabilities.

Current uses of Digital Human Modeling Tools

Today DHMs are able to be used to simulate tasks in order to estimate variables of interest. Such variables of interest include but are not limited to: movement timing, reach envelopes, fatigue and strength analysis, and injury risk (Polášek et al., 2015). DHMs are also used in many industries as a means to ergonomically assess designs (Chiang, Stephens, & Potvin, 2008; Mazzola et al., 2016; Sundin, Örtengren, & Sjöberg, 2000; Thompson, Liang, Klyde, & Allen, 2004). These analyses are typically performed before the physical work environment is created. DHMs allow the end user the ability to analyze designs and make changes quickly, for a minimal overall cost. The ability to analyze multiple iterations of a design before physical objects are created allow the end user to create designs with improved ergonomic characteristics, as problems can be identified and addressed early in the design process. Another benefit that DHMs provide the end user, is the ability to communicate their findings in a way which minimizes communication breakdowns between individuals, this is accomplished by providing information in both graphical and text form (Porter, Freer, Case, & Bonney, 1995).

Developing a Physical Demands Description from a Digital Simulation

DHMs have the ability to provide the end user with estimates of ergonomically relevant information in both static and dynamic activities (Raschke, Kuhlmann, & Hollick, 2005; Stephens & Godin, 2006). Using a DHM to simulate human behaviours in a dynamic environment would make it possible to estimate how a worker may perform the requisite series of tasks as well as the impact that the specific combination of tasks has on the simulated worker. In order for the simulation to contain maximal validity, it would need to be created utilizing all relevant physical information, i.e. heights, reaches, weights, distances, etc., as well as knowledge of the sequencing of tasks, and requisite time constraints, in order to faithfully simulate the task. This information required to develop a dynamic simulation is identical to that required to develop a PDD. As such, a digital simulation that can faithfully replicate dynamic job tasks would contain all necessary information required for conducting a PDD. This simulation could be used to serve as the basis for creating a PDD of the job, while providing information that is normally not possible to collect while conducting a PDD. Theoretically as the entire job would be captured, this would appear to overcome some of the issues that arise with traditional PDD generation, such as unidentified ergonomic concerns, mis-quantified demands of job (Coffey, Vandergriendt, et al., 2016), and lack of detail in provided within the PDD (Jones et al., 2005).

Previous Work Developing a Physical Demands Description from a Digital Simulation

Examining the use of a DHM to create a PDD was the focus of work previously performed by Ward (Ward et al., 2015) in collaboration with The Ford Motor Company of Canada, in Oakville, Ontario. The purpose of that investigation was to develop a new process for the re-deployment of rehabilitated workers based upon the "Advanced PDD" (or electronic PDD (ePDD)) output feature of the Tecnomatix Jack DHM packages dynamic simulation tool the "Task Simulation Builder" (TSB). The "Advanced PDD" was developed by this research group in conjunction with clinical stakeholders and the software vendor in order for the software outputs to be presented in a manner which would provide more relevance within a clinical setting. The overall goal of the project was to develop PDDs in a manner that would minimize communication breakdowns that may occur between individuals from the manufacturing floor familiar with the tasks performed and the medical staff treating the injured worker(s). As such, the ePDD output consists of relevant job information presented both in text and graphical formats, as well as providing the option of exporting a video of the simulation to accompany the report. One of the key findings with this project came when the ePDD was presented to representatives from the Ontario Workplace Safety and Insurance Board (WSIB). The WSIB expressed interest in the concept of an ePDD for use in two cases: an additional tool to investigate compatibility of an injury with the proposed mechanism of injury, and as a means of evaluating suitability within a RTW context.

There are significant limitations that were noted by Ward regarding the development and use of an ePDD. One of the major limitations for the use of an ePDD with a RTW context as suggested by WSIB representatives is that for any case in which an ePDD is used, the manikin used in the development of the simulation be closely matched to the anthropometry individual who is proceeding through the RTW process in order to best represent the work being performed in the simulation. Given the current status of the tool, when a manikin is substituted for another of differing anthropometry with the DHM software, errors may occur in the simulation that require the partial or complete redevelopment of the simulation.

Another limitation noted was the effect on the simulation environment on the manikins predicted posture. Within TSB, manikins are unable to interact with objects moving on their own, for example a vehicle moving down an assembly line. Ward simulated all tasks utilizing a static assembly line environment. The WSIB, Oakville workers union representatives, and the clinical stakeholders all acknowledge the change in working posture that a moving assembly line has on a worker, and currently the software is unable to account for that scenario.

The final major limitation of the study was that within a modern automotive assembly environment, multiple different vehicles are built on the same production line. If an ePDD was used to encompass an entire job on such an assembly line, it would be required to contain tasks performed on all models and trim levels produced, which at a minimum would require 4 (for the Oakville plant) separate simulations and possibly more considering the variety of options available on the vehicles produces. This would greatly increase the time and effort required to completely simulate a job, considering each simulation required between 9 to 20 hours to create, depending on complexity of the work task being simulated. In order to overcome this limitation, the highest production volume model could be chosen in an attempt to capture the most common exposures experienced by workers.

There has been no subsequent known work conducted with the newly created simulation based "ePDD." Adoption and implementation of the ePDD has also been slowed by the large time commitment required to complete a simulation compared to a traditional PDD and the uncertainty of the prospective benefit an ePDD provides compared to a traditionally developed PDD. On a related note, a large gap in research exists regarding the absolute utility of PDDs within a return to work context. PDD provide the user with information regarding the demands of a job and this information is vital when working within a job matching framework, however it is uncertain how exactly they are being utilized within a RTW setting. It is unclear if the information provided in the PDD document is being fully utilized, if there is information that does not provide a benefit, or if there is information that could potentially be of benefit that is not included within a traditional PDD.

Methodology

Study Overview

This investigation was designed to answer the following three (3) research questions.

1. How are PDDs used in RTW?
2. Are their any shortcomings of PDDs as it relates to their use in current RTW practice?
3. Does the novel approach of PDDs derived from a digital simulation (ePDD) address any perceived shortcomings of traditional PDDs in the RTW process, and how may this tool be used in current RTW practice?

Semi-structured interviews were conducted with participants who self-identified as having experience facilitating the RTW of injured workers for longer than one (1) year professionally. Participants were probed for information related to their experiences facilitating the RTW process focusing around three main research questions: how are PDD utilized within a RTW context?; Are there any perceived shortcomings of PDDs as currently utilized in RTW?; and does the novel approach of PDDs derived from a digital simulation (ePDD) address any perceived shortcomings of traditional PDDs in the RTW process?. Participants were provided samples of PDDs, as well as ePDDs *a priori* in order to serve as reference material to form the basis of the discussion.

Nineteen (19) interviews in total were conducted either in-person or via telephone, at the participants request. Participants were asked to schedule a block of time ninety (90) minutes length for the interviews. Audio recordings of the interviews were captured, and field notes were taken during the interviews to support the transcription process. Audio recordings for interviews conducted in person were captured using an Olympus VN-7200 Digital Voice Recorder (Olympus Corporation. Shinjuku, Tokyo, Japan) and the microphone on a LeEco Le Max 2 android cellular phone (LeEco. Beijing, China). Telephone interviews were conducted with the same cellular phone and Digital Voice Recorder, the cellular phone was placed into speakerphone mode to provide audio for the voice recorder to capture and also captured audio using call recording software. Audio was recorded using two different pieces of equipment in order to minimize the possibility and impact of equipment malfunctions.

Audio recordings were transcribed verbatim, and transcriptions of the audio recordings were analyzed to uncover overarching themes in the data. Three (3) interviews were lost due to equipment malfunctions, leaving sixteen (16) interviews with usable audio recordings. Only the interviews with usable audio recordings were included in the data analysis. Actual interview times averaged 93 (± 29) minutes. The shortest interview lasted 35 minutes in length, and the longest interview was 139 minutes in length.

The study was approved by the Office of Research Ethics at the University of Waterloo prior to contacting participants.

Participants and Recruitment

Participants were purposively recruited via two professional organizations, the Ontario Kinesiology Association (OKA), and the Association for Canadian Ergonomists (ACE). These two organizations were chosen as the decision was made to provide a homogenous sample set to aid in group interviewing (Palinkas et al., 2015), and these groups were determined to be organizations representing key stakeholders (Palys, 2008) in RTW, and thus contain a substantial number of potential information rich participants as a significant amount of work performed by the members of these organizations relates to the development and or use of PDDs with RTW.

Recruitment material was distributed to members of OKA and ACE informing association members about the opportunity to participate in focus groups related to the use of PDDs within the RTW process. The initial recruitment strategy did not provide any participants with agreeable schedules in order to convene a single focus group. The initial response to the recruitment material was such that it would not be possible to convene more than one (1) focus group in an ideal scenario, as such, the decision was made to change the experimental protocol, abandon the possibility of conducting focus groups, and to conduct one-on-one interviews with interested participants instead, in an effort to complete the data collection in a reasonable time frame. Participants were notified of the change in protocol before committing to participate in the study. Recruitment began in April of 2018 with the first interview being conducted soon after. The final interview was conducted in late September 2018. All individuals who responded to the recruitment material met the selection criteria. One individual who responded to the recruitment material declined to participate in the study after initial investigator contact. All other individuals who responded to the recruitment material agreed to participate in the study and were interviewed.

Participants were provided the option to either schedule an in-person interview on the University of Waterloo campus, or to schedule an interview via telephone. Once a participant agreed to participate in the investigation, they were sent an email containing a demographic survey, as well as a letter of information and consent. The participant was requested to complete both documents and return them to the investigator before the interview. Participants who elected to conduct the interview in person were presented with a physical copy of both documents upon their arrival, if they had not previously completed either document. As one of the goals of the interview was to gather information related to a novel method of PDD data presentation, the ePDD, participants were provided a link to a private online file repository containing samples of the traditionally developed PDDs and ePDDs for five

(5) automotive assembly line jobs to review in order to serve as the basis for that component of the discussion.

In total nineteen (19) interviews were conducted with participants. Three (3) interviews were conducted in person, and sixteen (16) were conducted via telephone. Three (3) recordings of interviews conducted via telephone were lost due to equipment malfunctions, data from these interviews was not used in the analysis.

PDD/ePDD Selection

Not all jobs where simulations were developed also had an available "Traditional PDD", reducing the pool of available jobs to present from the twenty (20) ePDDs developed by the investigator, NP. NP was provided with "Traditional PDDs" for thirteen (13) jobs of the twenty (20) simulated by the return to work team at the local automobile assembly plant. The five (5) jobs presented to participants were specifically selected in order to provide some exposure to the ePDD and not provide excessive information for the participants to review prior to the interview. These five (5) jobs were selected as they may have demonstrated concerns raised by the earlier work related to the development of PDD from job simulations using the Tecnomatix Jack software (Ward et al., 2015), as well as the job also having an available "Traditional PDD" available to NP. Two (2) of the simulations provided, for the "Shotgun Load" and "Muffler Heat Shield" jobs, were simulations that did not exhibit any of the concerns noted in the prior work, and were deemed to be accurate visual representations of the work completed and postures used to perform the work. The "Shotgun Load" job only required the manikin to pick and place vehicle components into the correct place, while the "Muffler Heat Shield" job also required the use of hand held fastening tools, both are common tasks performed in automotive assembly. There were three (3) jobs presented that exhibited some issue/concern as previously noted by the Ward work (Ward et al., 2015), "Rear Fascia Install"," Subframe Secure" and "Hinge Pillar Sealer". The "Hinge Pillar Sealer" job was chosen as the video of the simulation displays poorly simulated job tasks with the manikin moving “through” other objects in the simulation. The “Rear Fascia Install” job was selected as it demonstrates a scenario where multiple workers may be required to perform a task and how that impacts the observer of the final simulation, the job requires two workers to lift and install a part. While the motions of manikin performing the job were a faithful representation of a live worker performing the task, the addition of a second manikin into the simulation was not something explored in the Ward work (Ward et al., 2015) and it was unknown if or how that would affect the observer of the simulation judgements of the task. The ”Subframe Secure” job was chosen as it demonstrates the current limitation of the Jack software in that it is not possible to simulate a worker walking with an assembly line while performing tasks, and would simulate unnatural motion where the manikin in the simulation would slide along the floor instead of walk. See Appendix G for samples of material provided to participants.

Interview Protocol

All interviews were conducted by the author of this investigation, NP. For the participants who chose to participate in telephone interviews, upon connecting the phone call they were again informed that the conversation was being recorded, and they were asked to have access to a computer in order to review the PDDs and ePDDs provided via their email. For participants who requested an in-person interview, they were provided a laptop for use during the interview with the same sample files provided via email, preloaded for review during the discussion. Once the participant had completed both the demographic survey and signed the consent form, the interviewer informed the participant that the recording of the conversation was about to commence, upon verbal approval, the recording began.

Interviews were semi-structured, with a discussion stemming from key questions related to the issues encountered while facilitating the RTW process, the use of physical jobs demands data within the RTW process, and then specific questions regarding the sample material provided to the participant (ePDD).

Interviews began with the interviewer asking the participant question 1 as noted in the interview guide (Appendix A) "what role do you play within the RTW process?". The interviewer probed for relevant information as disclosed by the participant. The interviewer did attempt to follow the sequence of questions as noted in the interview guide, however if the participant provided information related to a future question that was probed as it arose. During the interviews field notes were taken by the interviewer to aid in transcription. After the interview, audio recordings were transcribed verbatim for analysis.

Data Analysis

Audio recordings of the interviews were manually transcribed verbatim by NP and loaded into QSR International NVivo 12 software for analysis. Transcripts were thematically analyzed following the reflexive inductive thematic analysis process outlined by Braun and Clarke (Braun & Clarke, 2006) in order to build out a data set founded completely in the information collected during the interview sessions. Field notes and memos developed during the interview were used to assist with the transcription, however were not analyzed for content. For the data analysis sixteen (16) audio recording were transcribed, as 3 recording were lost due to recording equipment malfunctions. The 3 audio recordings lost were all conducted via telephone.

To maintain confidentially of the participants, the title of "participant #" was used, any references made to their employer, or entities related to their business have been anonymized, for example using [employer] or [redacted], in place of the name of the participant's employer.

Transcripts of the initial three (3) interviews were read by two (2) researchers, NP and CM, in order to familiarize themselves with the data. Field notes were also reviewed in order to provide additional context to the transcripts before coding. Both investigators collaborated in order to develop initial themes that would best represent the data. The initial three (3) transcripts were then re-read individually to code the data and develop the initial code book. Due to the extended recruitment process, not all interviews were conducted before coding began. As subsequent participants were interviewed, the interviews, transcription, and analysis were conducted by NP with the use of the code book initially developed by both investigators. Part way through the investigation, three (3) interviews other than the initial three (3) were selected and coded by both NP and CM in order to ensure consistency in coding.

Ensuring Validity and Reliability: Trustworthiness in the Results

Ensuring trustworthiness in qualitative data was a major concern as the conclusions drawn from this research rely on the investigator's interpretation of the information at hand. Trustworthiness is akin to validity and reliability of quantitative data and it is composed for 4 key factors: transferability, dependability, credibility and confirmability (Tavakol, Sandars, Tavakol, & Sandars, 2017).

Transferability

The transferability of the result describes how well the findings can be transferred to another setting, context or group (Tavakol et al., 2017). This was addressed in this investigation through the use of thick description of the study population via background demographic information collection. This information was collected to do provide the ability to sufficiently describe the study population and the data they provide(Banister et al., 2017; Thomas & Magilvy, 2011). This description allows the information uncovered in this investigation to be contextualized and applied given the known context of its origin. The participants were also probed to provide "thick descriptions" of the phenomena they described (Geertz, 1973), where this was used to better frame the information gathered

Dependability

Dependability is the concern of the overall research process and how well the result are supported by the data. In order to ensure dependability data was collected to the point of saturation to capture all available themes. Saturation is the term generally used to refer to the point at which no new data is being uncovered by subsequent data collections (Stalmeijer, McNaughton, & Van Mook, 2014). Literature on the topic of saturation suggests that it should occur after twelve (12) interviews, with essentially all themes and >90% of possible codes uncovered in the data, given a fairly homogenous set of subjects (Ando, Cousins, & Young, 2014; Guest, Bunce, & Johnson, 2006). In this investigation nineteen (19) interviews were conducted in total with a homogenous set of subjects and sixteen (16) were used for the analysis, exceeding the suggestion that twelve (12) participants should essentially capture all relevant themes. Dependability was also addressed through the use interview guides, multiple (2) investigators to code the data, and the development of a coding book outlining the coding used in the investigation (Thomas & Magilvy, 2011). See Appendix A for the interview guide and Appendix F for the coding book.

Credibility

Credibility is generally developed through the examination of transcripts by multiple participants looking for similarities (Krefting, 1991). In order to ensure credibility peer examination was used (Thomas & Magilvy, 2011). Two investigators examined the data collected during the investigation in order to minimize any bias present within one investigator, and maximize credibility. One investigator was formally trained in qualitative methods (NP), while the second investigator, a research assistant (CM), was trained by the first investigator in the process of coding transcripts and thematic analysis following the process outlined by Braun and Clarke (Braun & Clarke, 2006). The investigators independently coded an initial set of three (3) transcripts in order to develop initial codes and themes, as well as independently coded a second set of three (3) interviews part way though the investigation in order to check consistency in coding. Upon completion of the initial coding, investigators met to discuss their findings and examine any differences in their coding. A code book was developed based on these findings in a format based on Ando's 2014 work (Ando et al., 2014).

Confirmability

Confirmability occurs once all three of transferability, dependability and credibility have already been established. It is the extent to which the results are based upon the study participants and setting instead of researcher bias (Stalmeijer et al., 2014). This was accomplished through the use of extensive documentation used throughout the investigation. Items such as reflexive field notes were used to document the researcher's thoughts (Magilvy & Thomas, 2009; Tavakol et al., 2017) and the development of a code book, were used to assist in development of confirmability.

Results

Participant Demographics

Nineteen (19) interviews were conducted in total with RTW professionals (14 females, 5 males). As noted, 3 interviews were lost due to equipment malfunctions, leaving sixteen (16) interviews for analysis (12 females, 4 males). The 3 participants whose data was lost include one (1) male and two (2) females, their data was not used in the analysis. The average experience in RTW of participants whose data was used in the analysis was 14.3±8.3 years. Participants self-identified their professional roles as follows: Ergonomist (9), Physical Therapist (2), Injury Prevention Specialist (1), Disability Management Specialist (1), RTW coordinator (1), RTW Specialist (1), and Health and Safety Manager (1). Participants reported the following professional certifications: CCPE (7), R. Kin (7), PT (3), CRSP (1), Other (2). Participants reported their educational background to be: Kinesiology (BSc. 10, MSc. 6) and Physical Therapy (BSc. 2, MSc. 1). Participants self-identified working in the following job sectors: Various (7), Healthcare (5), Logistics (2), Energy (1), Insurance (1). Geographically, participants lived and worked in 3 Canadian provinces: British Columbia, Manitoba, and Ontario.

Individuals who identified themselves as working in "various" industrial sectors were 3rd party consultants who informed that they, typically, would be contracted by employers in order to provide ergonomic/RTW services. These individuals noted performing work in multiple industrial sectors, however none of the individuals noted performing work in the automotive sector specifically. Those who identified themselves working in healthcare were employees of a hospital/hospital system and were responsible for facilitating their employer's ergonomics/injury prevention program. Those who identified working in "Logistics" and "Energy" expressed a similar focus to their work as those in healthcare, they were responsible for facilitating their employers RTW/ergonomics programs. The lone individual who identified their work as insurance focused was the only one who noted their work was focused on advocating for injured workers in the RTW process, all other participants noted their role was to advocate for their employer and mitigate any ongoing issues raised to them with a RTW case. All individuals who were not "consultants" noted working for employers >100 employees in size. While the individuals who identified themselves as consultants did not state their work could not include being contracted as an employee advocate, most noted their role as an "independent 3rd party" and not necessarily advocating for "the employer" or "the employee". It should be noted that "the employer" is typically the party who contacts, contracts, and remunerates the consultant for their work.

Theme Maps

Below are the theme maps related to the three research questions of interest in this investigation.

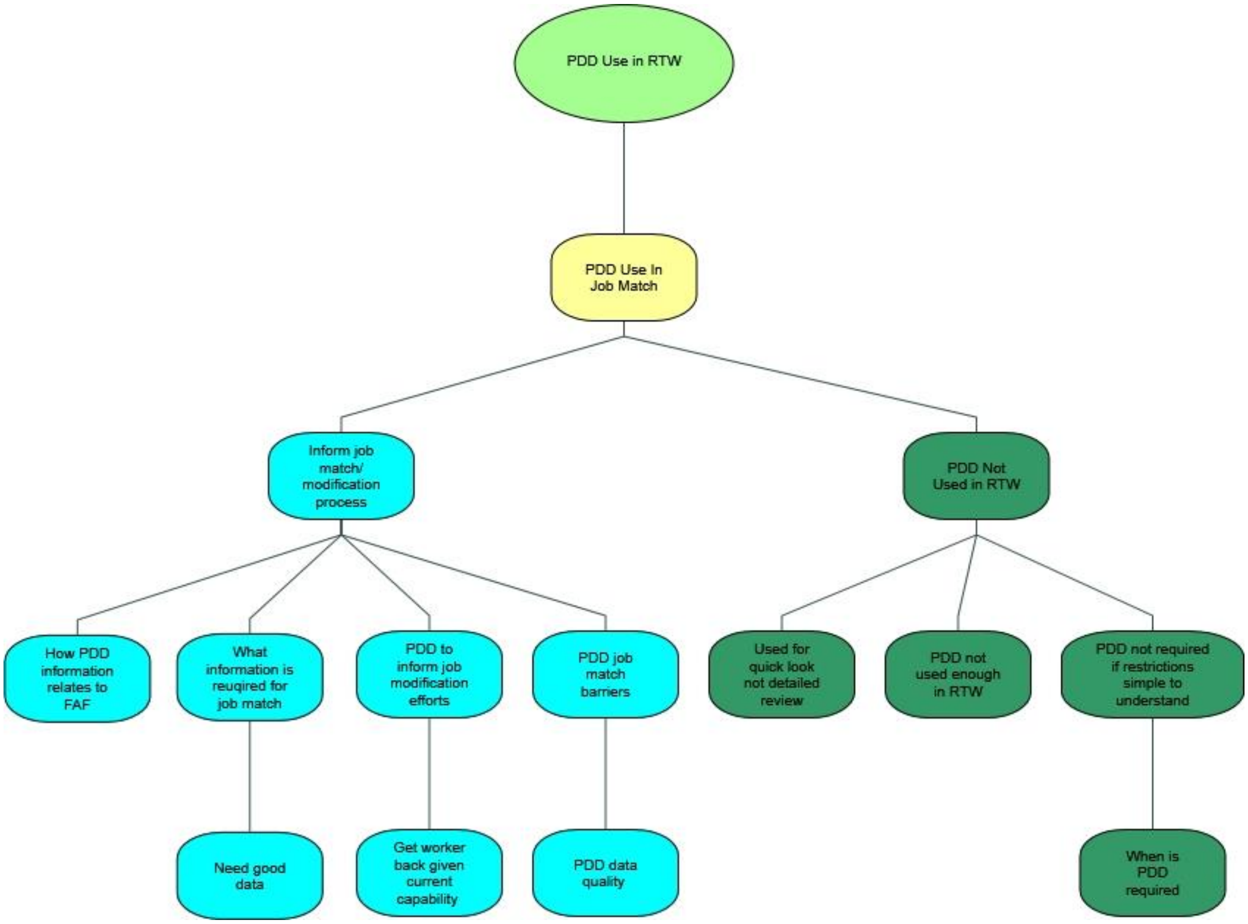

Figure 3. Mind Map Research Question 1 How are PDDs used in the RTW process

Figure 3 outlines the major theme uncovered within research question 1 "How are PDDs used in the RTW process?". One major theme was uncovered during the investigation, "The use of PDDs in the job match process." Within that theme, 2 major sub-themes arose: "PDD use to inform job match/modification process", and "PDD's are not used in the RTW process".

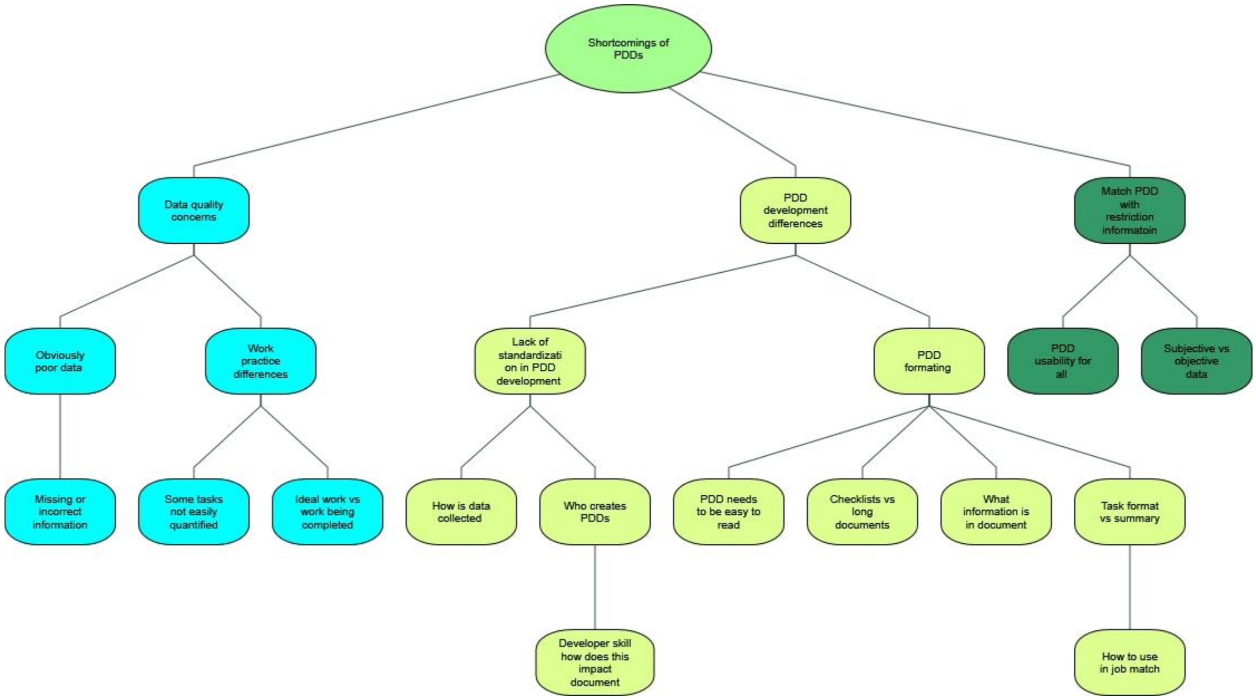

Figure 4. Mind Map Research Question 2 Shortcomings of PDDs When Used in the RTW Process

Figure 4 outlines the major theme uncovered within research question 2 “Are there any perceived shortcomings of PDDs as currently utilized in RTW”. Three main themes emerged from the data: “PDD data quality concerns”, “Development differences in PDD documents”, and “Match between PDD and restriction information”

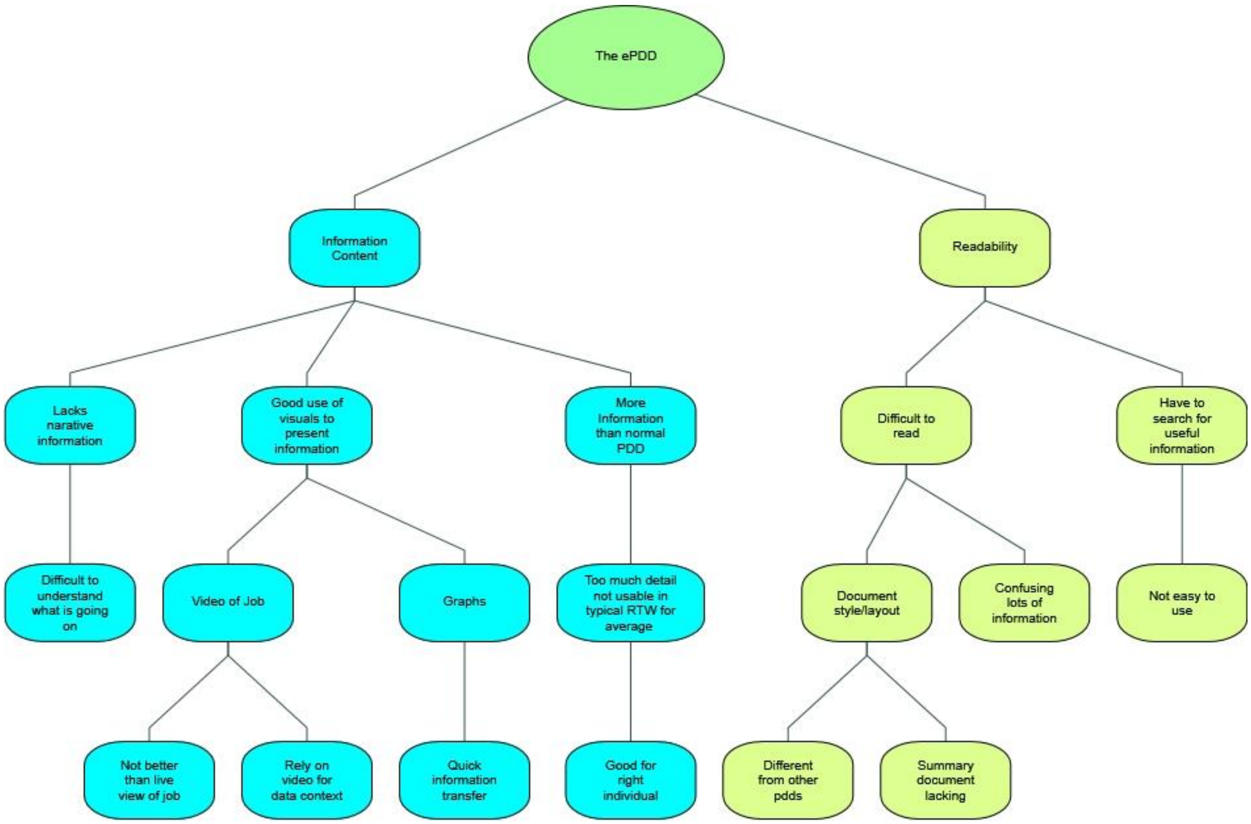

Figure 5. Mind Map Research Question 3 The Use of the ePDD in RTW

Figure 5 outlines the major theme uncovered within research question 3 “does the novel approach of PDDs derived from a digital simulation (ePDD) address any perceived shortcomings of traditional PDDs in the RTW process?” Two major themes were identified in the data: “ePDD Information Content”, and “Readability of the ePDD”.

Research Question 1 – How are PDDs used in RTW

With regards to the first research question, how are PDDs currently used in the RTW process, one major theme emerged from the data. The major theme uncovered is the use of PDDs as a comparison tool for use in a job matching process. Subthemes within the major theme relate to how PDDs are used to inform the job matching process, and that PDDs may not be used or are minimally used to inform the job match process.

PDDs As an Information Source for Comparison in Job Matching

PDD use in Job Matching

The major purpose that PDDs serve in the RTW process is to function as a comparison tool against an employee's physical restriction information to determine job suitability. The information related to an individual worker's functional restrictions are compared against the relevant information within the PDD. This process is performed to determine if the worker is capable of performing the work offered by the employer. As one participant explained:

> *they would be used by the case manager and they would typically try to do a comparison of documented restrictions or abilities and see whether or not a match with any particular job based on the PDA that we provide*
>
> *-Participant 2*

This suitability decision is not limited to the physical nature of the job. The cognitive and environmental demands of a job also may also be factors that serve as limiting factors of an employee's capabilities. These types of data may be contained within a PDD. For the job match process to be a success, information contained within the PDD must be useful objective data, as the document will be used to form the basis for the offer of modified work. Information such as applied forces, and reaches are deemed as useful. Problems may arise when "non-experts" as it relates to the job are responsible for performing the job match, as may be the case for many employers. Multiple participants noted that in RTW cases they were not the individual who primarily performed the "match"; however, they were the "expert" who developed the PDD document, and would be brought into the process to clarify any questions that the main decision maker would have regarding the demands of the job. These "non-experts" were typically noted to be "case managers" or "human resources" professionals that typically do not possess the background in biomechanics/ergonomics that the study participants possessed. Study participants noted that the ability to understand the details and be able to utilize the information provided in the documents efficiently, i.e. by possessing knowledge in biomechanics/ergonomics, was beneficial in the use of PDDs in the RTW process, and allowed for the greater use of detail in the documents.

> *… I know what mild neck flexion is, but not everyone who does disability management has an ergo background. So, if I was coming at this from someone who has like a nurse or psych background, and I saw neck flexion and some numbers I'm not sure how intuitive this should be for them*
>
> *-Participant 12*

Use in Job Modification Process

A significant use of PDDs with regards to the job matching process includes the PDDs ability to inform job modification efforts to obtain job suitability. The information contained within the PDD could be used to identify job tasks that may be a barrier in returning a worker to the workplace. As part of the job match process, if an injured worker is unable to perform their entire job given their capabilities, the information contained within a PDD may be used in order to determine what, if any, alterations can be made to the work that may allow the worker to return to the workplace.

> *…essentially, we get the physical demands analysis whether we did it, or is was external. We get the employee medical restrictions and go through the process trying to find any areas where if they have limited gripping, we go through all the areas where gripping may be involved, say, lifting, gripping, handling, and if weights or frequencies are kind of matching.*
>
> *-Participant 15*

This extension of the job match process may also include the provision of completely alternate work, as long as it is suitable given the workers restriction profile. The process of job modification is dynamic and tends to not follow any specific formula or protocol. At the core of the job modification process is the intent of the employer to provide an injured worker returning to the workplace with work that meets their restriction profile. How that modification occurs, and the extent to which the employer is willing to modify the work tasks for an injured worker is completely dependent on the employer's willingness and or ability to provide suitable work.

> *…saying okay maybe we can rework this job, lets go take a look at it. You know this job may work for him, let me talk to the supervisor and see if we can change things so he doesn't have to get out of his vehicle. I know it says here that you are supposed to get out and move the pallets or something, but maybe we can get it so he doesn't have to do that.*
>
> *-Participant 11*

PDD documents serve a vital role in the job match and job modification process in cases where the information contained in the document is sufficiently detailed and is able to describe the demands of job in a degree where the RTW professionals referencing these documents are confident that the job is completely documented. While interview participants noted a preference for documents with more information/detail, the level of information/detail preferred was something that varied widely.

> *I just found my files. So alright, I have the file on PDAs I probably should have pulled these out earlier. I've got some samples, I have a 13 page one form the [redacted] and that I did not do myself, and one from [redacted], oh my gosh 32 pages, its got a lot of checklists in there, and here is my stuff, these include everything like a glossary of terms….*
>
> *-Participant 16*

Not using PDDs in Job Match

A somewhat common theme among interview participants was the lack of PDD use in basic/simple RTW cases. In RTW cases where there are "obvious" restrictions, such as "no lifting, no pushing/pulling," that a PDD would not be required to perform a job match or job modification. Such restrictions are "simple" enough to understand and follow and that the process of PDD development or performing a detailed match of job demands to capacities would not be required in such cases. In cases such as these, for participants whose primary professional role focuses more on PDD development vs use, that they would not be consulted for assistance in the job match/job modification process. Other cases where a PDD may not be used, or be used very minimally would be where a worker's restrictions would generally limit a movement/action. In these cases, the PDD may be used as a quick reference, however only as a quick reference. PDDs are used only as a quick reference as many times it is not the details in a PDD document that drive the RTW process.

> *I don't care if the number is 100 or 150. All I care about is that this person has a back injury and they probably shouldn't be lifting. How are they feeling? They want to try it for an hour or two a day, good. We will build them back up slowly and get them there. It's one of those, it's more getting a range and a general idea where it is than the exact number*
>
> *-Participant 18*

Participants also note that for troublesome cases a PDD may no longer be the main focus of the demands side of the RTW process. In cases where external parties, aside from the employee and employer are involved, the ability for the RTW professionals to view a job live, and having a conversation with the injured worker about their concerns was seen as being superior to solely relying on documentation, no matter the detail, describing the job. The PDD document may provide some background on the job and allow the on site professional to quickly orient themselves to the job, but ultimately the ability to see the job live and speak with the worker would supersede any information within a document. In such cases, there may be concerns other than the physical nature of the job that factor into the determination of job suitability or previous failures of RTW efforts. These concerns may require further investigation and/or data collection outside of the scope of a typical PDD in order to successfully facilitate the RTW of the injured worker.

Specialists from WSIB will actually go out anyway and look in the job, the PDD is helpful for them as a starting point. They read it before they get there but they still want to go out and take a look at the job

-Participant 11

Research Question 2 – Shortcomings of PDDs

While PDDs are used as a tool within the RTW process as a means of communicating physical demands data, there are shortcomings with regards to how the document is currently used in RTW that limit its overall utility. Major shortcomings noted with regards to the use of PDD data in RTW include: Data quality concerns with the PDD, differences in the PDD development process, and the difficulty in matching PDD data to information provided by injured workers health care providers documenting their functional abilities.

PDD Data Quality Concerns

Obviously Poor Data

The use of "poor quality" PDDs is a concern with regards to the RTW process. The quality of the information contained in the document may affect the RTW process outcomes if a particular case becomes challenging. When facilitating RTW, as noted in the above section "Not Using PDDs in Job Match" the quality of a document may not always be of concern. As a case becomes more complex and the requirement for information to base decisions becomes greater, having a poor quality PDD may not only slow down the RTW process by requiring further information collection, but it may also lead to inaccurate/incorrect decisions that may hinder the workers progress in returning to work.

I would say a lot of the time we often times we redo the data because the data we need with frequencies and being really objective and like the micro details. I will re do them because they are usually checkboxes, and if I am going to make an argument I need to know if it is 6 or 33 [percent of the day] because that is a big range.

-Participant 15

Concerns of PDD quality that are quite apparent such as incorrect information may require professionals to request a re-collection of information, or in some cases the professional will be required to collect the information themselves in order to guarantee data quality. This will increase the time and cost requirements associated with the management of the case. In scenarios where this "poor quality" data is not identified; it may lead to suboptimal/incorrect decisions being made that are supported by "evidence." It is the responsibility of the RTW professional to ensure that the decisions they make are based on the correct information. In situations where the RTW professional is unable to reliably stand behind a decision based upon some information they have been provided, it is in the best interest of the RTW professional to not use the questionable information and risk their professional reputation. It is a safer course of action to find another means of gathering the required information.

> *…they have a PDD, they also gave me a summary of the physical demands listed on her job description which again is kind of confusing, but it says can lift up to 120lbs frequently and regularly. I think to myself that isn't right. So, I think even the descriptors we use in the WSIB world, the return to work world, I know there is sedentary and description of sedentary but there is a lot of terminology we use if something is frequent and regular. 120lbs I think they were trying to say shared or maybe mechanical assist but that was nowhere listed I think that you have to be careful with how, and what, we describe like when I saw that that's pretty confusing. Likewise, there was another one where that was left off, and it said that we lift this every single day, and it was nowhere*
>
> *-Participant 7*

Work Practice Differences

Another concern with regards to the use of PDDs in the RTW process is that much of the time, participants note a discrepancy between the work that is being performed and the work that is being documented. It is not that there is voluntary misrepresentation of the job demands by workplace parties, but that in many instances, the way in which a worker is instructed to perform a task may not be exactly, or even remotely close to, how the worker would actually perform the task. In highly dynamic environments such as healthcare, construction, or material handing a common concern related to how to best describe the “actual” demands the worker is exposed to while performing their daily job duties.

One example provided by multiple participants who practice ergonomics in healthcare is the manipulation of patients when examining the daily duties of nurses and personal support workers. These workers spend a substantial amount of training in order to increase their personal safety while lifting and manipulating patients, as well as being provided with assistive devices such as patient lifts. Issues arise when the actual work practice an ergonomic professional may observe may be different from that in which individuals are trained. This example is ignoring the vastly different physical exposures to which different patient populations may expose staff. In scenarios where there are mechanical devices to perform patient lifting, and the official protocol is to utilize said devices. If there is a scenario where it is no longer possible to utilize the device, and where teamwork and physical patient manipulation is required for patient handing, questions arise as to how it would be possible to define/describe an amount of effort/force a worker must exert if the load is dynamic, occasional, and shared by multiple workers.

Uncertainty in job demands is not something that professionals within RTW who attempt to utilize physical demands data can trust when making suitability decisions. For example, if there is equipment that is available that minimizes the physical load to which a worker is exposed, i.e. a lift assist device, it is challenging for the RTW professional to quantify those exposures as they may vary depending on the load being manipulated. However, the relationship between load and exposure is not guaranteed to be linear, or easy to quantify. Also important are the changes that may occur throughout the course of a year, and how the job requirements change, this leads to challenges when attempting to describe the work in a PDD type document. This also makes the use of developed documents challenging in RTW as the work can be highly variable and documents may not provide the most accurate description of the job as it is performed at the time of evaluation during RTW. This is one of the reasons why the RTW is conservative by nature and the PDD as a tool may not always provide the information that RTW professionals desire when attempting to match capacities to demands.

> *Once of the challenges is to see the job, the entire job and all the aspects of then job, as you know I will be going in to see a job and it is impossible to see every single task they will do over an entire year because it is so varied, that you need to ask the right questions. You need to know to ask "what do you do here? And what do you do here? And what do you do once in a blue moon that I will never see, it is difficult to get accurate information.*
>
> *-Participant 17*

PDD Development Differences

Concerns were raised with how the PDD documents were developed and the influence that may have on its use in the RTW process. Development concerns relate to how the process occurs for the collection of PDD data, as well as the formatting and presentation of the information in the document.

PDD Data collection – Lack of Standardized Methods and Practices

Concerns were voiced regarding how the job demands information is collected during the development of a PDD as well as the lack of standardization involved in that process. It is generally understood that there is no one definitive process that meets all the needs of all parties in all scenarios when developing a PDD. While there are guidelines (Occupational Health Clinics for Ontario Workers, 2014a) with regards to how the entire process of PDD development occurs, they are merely that, guidelines. This lack of overall standardization has been identified as a challenge for individuals attempting to utilize PDD's within the RTW process.

When attempting to utilize a previously developed PDD, participants expressed concerns with the quality of the information within the document itself, often questioning the accuracy of the documents intended to describe the work being performed. The "quality" of the PDD documents conducted by 3rd parties, as far as the participants of this investigation are concerned, is not consistent and very rarely "good". Third parties refer to any individual who is not the current reader of the document. This is not limited to "non-ergonomists", multiple participants made specific reference to documents they have attempted to utilize conducted by other "professional ergonomists" which the participants felt were not of a high quality. Specific concerns with documents developed by 3rd parties varied, however most common were concerns that the data in the document did not appear correct, even at a surface level, or was completely missing critical job information in the document. While it is reasonable to expect that a professional should verify the information presented to them if possible, many of the interview participants note that it is common to see poor quality information provided, often times causing the professional to question the integrity of the process involved in the creation of the document. If the quality concerns are significant, professionals may choose not to use the document and recollect the information themselves, if that option is possible, as a means of guaranteeing the quality of service they are providing. This duplication of work leads to further cost increases and time delays in the RTW process.

> *…its almost not enough information, right, like I want to I want more information. Standing is constant but there are no details, there no description, so somebody standing is constant and they just assumed that the reader knows why they are standing. Its like really? The job requires no walking at all, and it kind of makes me doubt the content as well.*
>
> *-Participant 14*

A frequent comment among participants is the concern for PDDs developed by untrained, or minimally trained parties. Groups of focus include: students, Health and Safety, and Human Resources professionals. These groups were identified as common developers of PDDs, as it is believed that many employers may not maintain individuals on staff with the training and expertise required to develop "quality" PDD documents. Some employers may not even maintain PDD documents for jobs within their facility, only attempting to develop the documents reactively, as required. This may lead employers to utilize individuals who may not possess the sufficient training to develop a "PDD," as the resources, i.e. time or money, required to obtain a trained professional may not be available. As such, it is typically unknown as to how the information presented within a pre-developed PDD was obtained. The questions that are raised with regards to the quality of the information presented within a PDD ultimately lead to overall concerns with how the document may be used in the RTW process.

A point to note when specifically focusing on students developing documents, references were made to the high development cost required to build PDDs, i.e. time. For students that are overseen by a trained professional, the use of students to develop PDDs was perceived as an efficient use of the professional's time. While the students may spend a significantly greater amount of time vs. a trained professional when collecting the data and developing a PDD, the professional overseeing the student may perform work of a perceived higher value, and then spend a short amount of time to review/check the document to ensure that the student's work was complete, versus collecting all the information themselves. This was believed to be an area that may potentially provide significant cost and time savings for the professional ergonomist. While this does not eliminate the quality concerns that may arise with documents developed by minimally trained individuals, it does serve to minimize the possible concerns as documents are reviewed by a trained processional.

Data Quality concerns within PDDs may stem from the lack of any standardization in the PDD development process. When questioned on their PDD development process, participants provided a wide variety of answers as to how they approach a data collection. Some of the participants noted that in the PDDs they develop, tangible information such as accurate object weights and reaches were not something their employer required, only requiring approximate values, as such they did not attempt to collect that information.

…Measurements. I have never used a tape measure before, so recently I have started to include the height of IV poles height of hospital bed trays because sometimes when something is really short and doesn't adjust that can really affect and individual's mobility in the workplace measurements.

-Participant 9

Participants whose professional focus was to support typically unstandardized work, such as healthcare, noted the issues with regards to obtaining consistent "quality" information for some of the physically more difficult tasks, such as patient handling, and the variation inherent in those measurements. Other participants noted their procedure for collecting data involved the use of multiple trials, calibrated data collection tools, and strict adherence to a set of standard operating procedures to ensure there is a level of quality and trust in the data collected. While it may be very difficult to develop a method to standardize the measurement for every metric of interest in all possible scenarios, the lack of standardization with regards to how to approach a PDD data collection is concerning. When examining a PDD document, RTW professionals may be, and most likely are, unsure how the information was collected. As it is typically not possible to understand the parameters under which information was collected, the end user of the document cannot begin to assess the quality of the information in the document. The reader of a PDD does not know If the information they are reading was collected using a specific method, or was just collected "to get data". This uncertainty makes trust in the documents developed by others difficult and professionally unwise. This ultimately limits the overall utility of the document as a means of conveying information useful in the RTW process unless all parties in the process are certain of how the information was collected.

The scope is enormous, the variation in quality is also enormous. Other times I'll have a super detailed one from a really good company and it has everything, grips used, times, forces movements down to the finest detail. It varies with the job and there is a huge variation.

-Participant 10

What information is contained within a PDD, and how that information is presented varied as widely as the collection methods used to develop the document. Participants noted that the variety of document structure and included content created challenges with regarding to obtaining required information and efficiently using the documents in RTW. When utilizing a PDD document within the RTW process, participants stated that they prefer documents that provide the information they are after in a manner that is simple, quick, easy to read, provides all the information they require about the job, and provides some context to frame the information being provided. With that being said, participants generally held a preference for document styles/structures/content of which they were familiar in using.

Usability concerns were raised with regards to documents which contained both too little, and excessive amounts of information detail. This also applied to contextual elements in the documents. Documents which provided too little overall information were generally deemed to be incomplete, and documents which provided sufficient job demands information, i.e. weights lifted, postures, etc., but very little contextual information were deemed difficult to use. A lack of contextual information was seen as making it difficult to utilize the information, as the individual using the document may not comprehend how the information presented in the document relates to the work being performed.

> *then I think that yea, I like the ones that go beyond checking off that they are sitting for 33-66% of their day. What does that mean? Is it broken up? Is it 5 minutes at a time? Or is it they are sitting for 60 minutes and not allowed to get up? I guess yea, context, but that is still functional information.*
>
> *-Participant 10*

Pictures, or other visuals were noted as being useful for providing contextual information without the requirement for long task description. Usability concerns raised with excessively detailed documents related to the time required in order to find relevant information. While contextual information is useful in a PDD, participants expressed a distaste for documents with long, verbose, narrative descriptions of tasks that lack a quick, easy to read means of obtaining relevant job information. These documents may become "difficult" to utilize as the reader is required to search the text in order to pull out the information of interest, further increasing the time and mental capacity required to use the document.

PDD's and the Matching of Functional Capacity information

While poor quality information evident in the PDD document hinders RTW efforts, similarly a document that does not match the information being provided for comparison is equally as difficult to use in a model of RTW that attempts to match job demands and worker capacities. While not directly under the control of the participants in this investigation or the result of concerns related to the PDD document itself, a significant theme with regards to the use of PDDs in the job match is that much of the information they are attempting to match, i.e. functional abilities forms, do not contain clear directions/restrictions. Participants note the difficulty with attempting to perform a job match when presented with functional restrictions such as "light duties" or other equally general terms. When an employee presents such documentation it is up to the RTW professional to either attempt to determine what information the HCP is attempting to convey, obtain further clarification as to what the HCP determines is the best course of action for their patient, or to provide the worker with highly accommodated work that in no way could be considered challenging the restrictions on file.

> *…for example, prolonged walking, or standing as tolerated. Well, I don't know what to do with that, so you need to quantify it more to make a more accurate judgement.*
>
> *-Participant 19*

The RTW process requires the collaboration of many individuals, with a wide variety of professional backgrounds. There is no single source of information with regards to how individuals are trained, as such it is not uncommon for different parties in the RTW process to operate with differing definitions for commonly used subjective terms such as “limited”, “occasional”, “light”, “prolonged”, etc. These words may hold a definition according to one party, however may define a completely different set of criteria to another professional from another discipline. The lack of a common language that RTW professionals speak is noted as a significant hinderance within the RTW process. While there are some definitions in place developed by 3rd parties in an attempt to mitigate some of the variability in the description of such values, like those definitions defined in the National Occupational Classification (NOC) (Mnistry of Public Works and Government Serives, 2003), the use of these terms within the RTW may not be well understood by all parties. Specific issues were raised with the definition of descriptive terms such as definitions of task frequencies and their use in the RTW process. While a document such as a PDD may provide detailed information such as job task timings, the interpretation of those values is generally not consistent across professionals.

> S*ometimes we need to get clarification from somebody's health care provider who has written the FAF, and a lot of the time we don't get any response. Especially the ones that say no repetitive back bending or infrequent lifting. Like what do you mean by that? This job has lifting once every 15 minutes, is that infrequent to you? Or does that mean can they do that?*
>
> *-Participant 13*

Further adding to the variability, examples of “grey area” interpretations include jobs with sporadic or highly variable demands. Questions arose with regards to how one interprets the demands of a job which may require a highly repetitive task, however only for a very brief period during the typical work day. Participants themselves noted concerns/issues/questions when attempting to facilitate RTW for individuals with such jobs. With single tasks the default conservative course of action typically is to remove it from the job requirements during the period of occupational restriction, however the question of what timeframe is required and what cut-off value is used to determine repetitive movement is a question which RTW professionals do not have a definitive answer. This makes the use of PDD data in RTW difficult as interpretations of descriptive information vary.

Ensuring that PDDs are useable for all audiences

PDD information is not useful if the reader is unable to understand what the document is attempting to describe. While the participants of this investigation are RTW professionals with kinesiology/ergonomic background, it is understood that many of the individuals within the RTW process do not share a similar educational background. Over and above the concerns regarding data quality within the document as noted by trained professionals, is the concern that in some cases the documents themselves are difficult to comprehend or attempt to convey information in a manner that is not usable for a trained professional, let alone to the average reader. From a usability standpoint, participants voiced a concern that some of the PDDs they have utilized in the past may not have been the simplest to use. Of note, were concerns that relevant information may not be presented in a manner that allows the reader to understand what is occurring. For example, a document that provides necessary information, such as heights/reaches in a table, while providing a list of weights and forces on another page would not be a structure from which a reader would be able to easily and quickly obtain the desired information. Poorly structured documents increase the mental workload on the reader and may open the possibility for misunderstandings to occur as readers are required to gather information from many sections and combine the relevant information to develop their idea of what the work the document is attempting to describe.

> S*ome of them want to say, yea, lifting is involved but what are they lifting? If that was checked off, and then the person is not allowed to lift anything, uy7how are you supposed to figure out an accommodation for that?*
>
> *-Participant 13*

While many of the professionals in RTW may have some knowledge of ergonomics and/or kinesiology, such as the health care practitioners treating the injured workers, often times employers may not have front line staff with a strong background in kinesiology/ergonomics. Groups specifically noted who may serve a role in RTW that may not have a strong kinesiology background include: Human Resources, Health and Safety, Production Management, and worker's Union representatives. These groups, depending on an organizations structure, may play a significant role in the RTW process. These groups were specifically noted as being more likely to become overwhelmed or be unable to gather information when presented with a document with a substantial amount of technical information outside of their area of expertise.

> *Okay, so what is one that we, ok, for hand dexterity, when we talk about pinch grip, palmar grip, so, when I get to hand strength, and dexterity. Managers and union reps and workers or even your return to work, they don't necessarily know what forearm torque and fine manipulation is*
>
> *-Participant 8*

While there is a general consensus that a useful PDD document is developed with simple communication in mind, there was no consensus as to how to achieve that goal. Participant responses were varied in how much information they desire to see within a document. Some individuals responded with answers that expressed a desire for concise documents that express demands in simple terms, while others desired complex detailed documents generally stating that "more information is better", while also acknowledging that information in a simple format is required for less savvy readers. One strategy commonly suggested to overcome the potential confusion was to develop the PDD document in a more linear fashion where all relevant information is presented together, with sufficient narrative information to frame the data in the document, eliminating the requirement to jump between sections of the document in order to gather information for specific job tasks.

…this was a common flaw with other PDD styles, and a common flaw when other people are filling them out is just to have blank information. To say yep, that occurs, and they to not give a description or just to say lifting happens up to 50 lbs, but do not give some examples. You are really trying to paint a picture to the reader. The reader could be a doctor, or the WSIB person whatever their title is, the claims person, the occupational health nurse, etc., they are somebody who has not seen the job. I also like the PDD to have pictures of the job, I think that does make a better PDD. So, in summary, I would say having an extra column to further describe your NIOSH frequencies, you would have to 6-33% but then you would explain what happens there, I think it would make for a better PDA. Having some pictures whether at the top of each page or the top of each section, something like that helps to paint that picture for your reader. I like a summary page or a cover page, the reality is that your reader is likely not to have the equivalent qualifications as you, and not everybody is an ergonomist, and not everybody has the same knowledge and understand of the human body in the same way that we do. As much as you might have all of those charts of data, and it makes sense to me, and I can tell you how I have documented the whole job, but without a summary page people will gloss over and they may just pick a few things.

-Participant 14

The suggestion to present information in a format to summarize the overall job/tasks with measures of interest was also noted as potentially beneficial for experienced knowledgeable professionals. The addition of an easy to comprehend summary section could allow for quick retrieval of relevant information, i.e. max weight lifted, for use within the initial job match process. This would allow readers of ideally all levels of training to effectively utilize the document, while also providing the skilled professional the increase in detail required to make decisions requiring a greater amount of precision.

Research Question 3 – Using PDDs From Digital Simulation to Overcome Shortcomings of PDDs

The overall impression of the ePDD was that in the current format, the tool could not, and should not replace current methods of developing physical demands descriptions. The ePDD did not address concerns raised with regards to the current method of PDD development, and may be more challenging to use within the RTW process compared to many of the current styles of PDD used in practice. Participants raised concerns with the current method of PDD development related to the structural layout making the documents challenging to read as well as the quality/types of the information provided in the documents. These concerns were not resolved with the ePDD and participants found themselves raising the same concerns. Participants did, however, find positive aspects of the ePDD compared to a traditionally developed PDD. These benefits were centered mainly around the use of visuals within the tool that are difficult to reproduce with current methods.

Readability of the ePDD

When presented with the ePDD document, participants typically required some time to acclimatize to the layout of the document. Some noted that the format of a multi-sheet excel file (a workbook of multiple spreadsheets) was a structure they did not have a significant amount of experience using, and many participants questioned the interviewer on how to navigate through the document. Often times the participants did not explore other "sheets" within the document and remained on the "sheet" where the document opened, not expecting it to contain multiple "sheets". The ePDD document was found to lack overall readability by many participants. This concern aligns with the issues participants raised with regards to traditional PDDs and their difficulty consolidating information across multiple pages of a document.

> *when I look at this the paper part I can't at all tell what's going on or what the task is*

-Participant 6

Participants noted that the layout of the document and the information presented in the document are a challenge to read. Participants had difficulty understanding much of the information within the document at first glance, and without clarification from the interviewer. The ePDD document does not provide the reader with instructions or information as to how the data within the document is collected or displayed. While much of the information is labeled, a significant amount of information that is used as source material for the graphical presentation of data is also presented to the reader. Many participants found themselves "lost" within the section of the ePDD file containing the source information, while others were able to comprehend the information and would be able to reference that for specifics that would be difficult to extract from graphics. Those who became "lost" in the source material believed that the presentation of said material would be a determent for individuals who do not possess a significant amount of competency with the ePDD document, as there is a significant amount of information presented in tabular form with no context to orient the reader.

> *in the raw data bit lifting lowering gives you an idea of the weights of everything applied force. Yea the raw data is all there, but for your average person who isn't an ergo it isn't going to be super intuitive*

-Participant 12

The layout of the document was not found to be very useful in RTW. When probed regarding their perceptions of shortcomings of PDDs currently used in RTW, participants preferred documents that were structured in a manner that described the assessed job by task and provided a quick means of retrieving relevant information. Participants believed that this task by task breakdown of a PDD would allow for ease of use within RTW as it allows the reader to quickly identify tasks that may or may not be suitable given a worker's restriction profile. This breakdown allows the RTW professional to quickly determine what may require change when attempting job modification. The current format of the ePDD, providing summary data, does allow the reader to quickly determine if an entire job may be suitable, however does not provide a quick means of identifying problem tasks that might require modification. Acknowledging that the ePDD provides the reader with summary data regarding the job, it was requested that as a potential modification the ePDD could be provided with a summary sheet/section that could include all potentially restriction relevant information for quick review as a means to increase usability in RTW.

Information Content

Lack of Narrative Description

Similar to concerns with traditionally developed PDDs, the lack of narrative description was noted as a significant determent to the ePDD document (excel file). Participants found the lack of narrative description a challenge, as they were required to rely on the video which accompanies the document in order to understand what is being assessed/described within the document. When attempting to comprehend what was occurring, some would review the descriptors within the on-screen prompts provided in the video and attempt to compare that to some descriptors within the document. Participants found this to be just as, if not more, cumbersome as traditional PDDs where all relevant information is not consolidated, as they now must watch a video, rewind/pause/play/fast forward the video to bring up the on-screen data, and attempt to align that with a document in another window on their computer. This further adds to the concerns raised with regards to the usability of current PDD documents, where now the user is now not only jumping between sections of a document, they are also required to jump between screens on their computer when viewing the ePDD document and the video simultaneously.

> *…raw data not so much, because in the task of details it doesn't say neck extension or anything like that right. So, then the question would be can we clearly identify which part of the task this is from, the reach? I have to go*

back and look at the video though and hopefully in the video we can go back down and say "so the greatest reach was at this aspect."

-Participant 8

When examining the ePDD in conjunction with the context provided by the narrative description of the accompanying traditionally developed PDD, participants found the ePDD to be slightly easier to understand. Participants had a noticeable concern with the lack of background information regarding the job tasks being performed in the ePDD and the implications they may have with regards to how the information is understood and utilized within a RTW context.

Excessive Detail

It was believed that the ePDD in its current form provides too much detail for use by the average RTW professional. Participants found themselves overwhelmed when initially exposed to the document. While it would be expected that when presented with a novel means of expressing data, individuals would have some difficulty acclimatizing themselves to the document, participants found the ePDD to present "too much" data. Many participants found themselves struggling to orient themselves within the document, as it may not be structured in a manner that may RTW professionals may have experience using.

So, lets looks at posture. I still think that for someone without an ergo background it will be overwhelming, and someone with it, it will be super fun because its like "wow its super detailed," but I think it will overwhelm people without it the posture and task demands

-Participant 12

Participants found that the quantity of information provided for certain aspects of interest, such as summaries of joint angles over a cycle, might be excessive and unnecessary for use in RTW. Concerns were raised with regards to how the joint angle information is presented, and how the quantity of that information may overwhelm, confuse, and hinder, even experienced RTW professionals who may attempt to use the document in practice. This information, while potentially useful to the right individual in the right scenario, does not directly serve a benefit in RTW overall, as rarely are an employee's functional restriction provided specifying detailed joint angles. As such, this information may not assist in the RTW process as the information is not presented in a manner that allows for the ease of comparison to possible restriction profiles. While the ability to quickly determine maximal joint angles, which may be of concern for joints such as the shoulder, specifically for overhead work, was deemed beneficial, the entirety of information provided does not align well with the information they are presented to serve as a comparison target. Certain information such as loads lifted and carried match up well with typical tangible restriction information, however this information does not consist of the majority of the ePDD document. Other Information in the document such as "applied force" or "hand travel distance" may indirectly relate to a possible restriction, however, are not presented in manner that makes for an easy comparison, or simple comprehension by typical readers of a PDD document. The addition of such information may be helpful in RTW, however, as the measurement does not directly relate to typical restrictions it does not directly assist in the job match process and may lead to possible confusion with regards to the information within the document and errors within the RTW process due to information overload.

Participants found the inclusion of analytical information such as estimated low back forces and energy expenditure unnecessary within RTW. This type of information is not used within a typical RTW, and this most likely would further serve to confuse the untrained/unexperienced reader of the document. Some participants noted that they would be able to use this information as a means of quickly examining the job to assist with potential job modifications, i.e. specifically for a low back injury, however would most likely not be used in another capacity in RTW. These data while useful for the highly trained professional, are more suited for use within a detailed ergonomic assessment of a job, and not for presentation within a RTW case.

> *I think I would ignore for the most part like energy expenditure, I would definitely ignore stuff not related to the injury… like if you do get a prescription that information is nice to have, but 99% of the time nobody is writing down degrees of flexion angle. I don't know if I would send that to physio. It's hard because it would be really cool to have this if it came up but it is not useful day to day. It would be nice to have on hand, but it would be tricky, right, more information is nice because you might need it, but would I use it every day? Probably not.*
>
> *-Participant 11*

Using Visual Information to Support the PDD Information

While the ePDD document was not found to be overly beneficial as a whole for use within the RTW process, the graphical display of information was noted as a significant benefit over a traditional PDD. As participants expressed preference towards documents and structures that provided information in easy to understand formats/structures they found the visual nature of the information within the ePDD to be easy to understand and a benefit to the document. While some of the information was difficult to comprehend, participants found the addition of visuals, i.e. charts, graphs, within the document beneficial for providing context to values provided. The visuals provided a quick means of communicating the information. While information such as the low back loading metrics may not be useful in RTW, participants found the graphical presentation a useful means of conveying the information as it is provided simply and with reference to accepted guidelines. Participants found the extra context of the added "NIOSH action limit" to be a useful addition to the graph as a means of contextualizing the information especially if presenting the information to a lay audience. With regards to information that was deemed more useful in RTW, the graphical nature of the "reach metrics" sheet within the document was noted to be useful as a means of presenting and contextualizing information for lay audiences. The graphical presentation of the information allows for concepts that may not be innately evident to readers to be easily understood. Forward hand reaches may not be a concept that many professionals outside of ergonomics may easily grasp, however the addition of the graphic depicting the reaches provides another source of information with context that users are able to better understand.

> *looking at the ergo data tab and the reach metrics tab I liked to I think it's still relatable. I know it's still very detail oriented but it's still relatable and an average HR person would be able to get it that if you are reaching beyond 50cm to do something that is too far and that could lead to an injury*
>
> *-Participant 10*

Addition of Video of the Job Simulation

The addition of a video of the task being "performed" was noted as being a significant benefit with the ePDD document over and above a "traditional" PDD. The video was thought to provide context to the information presented in the ePDD, and helps orient the reader with regards to the information. Participants noted that the use of a video of a simulation would not supersede viewing an individual perform the tasks live and in person, nor viewing a video recording of a live individual perform a task. However, the video was noted to potentially serve a benefit when attempting to share information with parties external to the workplace or other individuals unable to view a worker in person/on video. When probed, participants noted that there may be minimal potential differences in utility between a well-developed job simulation and a video capture of a live job task. There were situations where participants noted that a simulation may provide an increased benefit vs. a live video capture. Participants identified scenarios such as confined spaces where video may be difficult to capture, as possible situations where the use of a simulation may allow the viewer to "see" what would be occurring during a task in a manner not possible/very difficult to achieve with a video of worker or a live observation.

What was noted as a potential point of concern were instances where the simulations were not "smooth" or "life like". In cases where the simulation did not appear very similar to a live worker, participants raised a concern with regards to the potential impact on the quality and accuracy of the data within the ePDD. It was believed that a not "smooth" or "life like" video would reduce the "trust" in an accompanying document as the video would not realistically reflect the work being performed, or exhibits significant "errors" or motions that would not be expected by a real-life worker. As the information in the ePDD document is based on the simulation, participants believed that simulations of a poor visual quality may also impact the quality of the information contained in the document, and thus reduced overall trust.

Discussion

This study helped us learn if information from an ePDD could improve current RTW practice related to the use of PDD data. Participants recruited in this investigation possessed a significant amount of experience facilitating the RTW process and utilizing job demands information. These participants were able to provide a significant amount of information as it relates to the use of PDD data to facilitate RTW. It was the goal of this investigation to gather information from "information rich participants" who have experience facilitating RTW. Both the Kinesiologists and Ergonomists provided a substantial amount of rich information related to their experiences using and creating PDDs. While these groups did provide "information rich" participants, the proportion of the study population who focus on servicing industries with "unstructured work" i.e. healthcare, was significant. These individuals have significant experience in RTW and were able to speak to the use of PDDs in the process, however, a tool such as the ePDD is not the ideal for use in their industries, as it has been developed for highly structured work. While the information provided by the study population as it relates to the use of the ePDD is valuable in a broader RTW context, a study population who is more experienced in facilitating RTW in structured work environments, i.e. (automotive) manufacturing, may have provided more relevant information given the ePDDs intended use. Interviews in this investigation were performed both via telephone and in person. There was a difference in interview length for the in-person interviews vs those conducted via telephone, with the in-person interviews being shorter in length, 93 ±29 minutes (telephone) vs 80 ±20 minutes (in person). With regards to research questions 1 and 2, the information collected was similar, however with regards to research question 3, the in-person interviews differed from those conducted via telephone. For the in-person interviews, the participants were provided with a laptop computer by the investigator, none of the participants requested to use their own personal computer, where they would be using their own personal computer while interviewing via telephone. It is uncertain if the scheduling of an in-person meeting had an effect on participants willingness to provide long, more detailed answers. While no in-person interview lasted longer than 105 minutes, 5 interviews conducted via telephone lasted 120 minutes or longer. Gender did not influence interview time, females averaged 93 minutes and 40 seconds, while males averaged 93 minutes and 8 seconds.

One of the least expected themes that emerged from the interviews is how little PDDs may be used within the RTW process. It was a common theme among many participants that a significant amount of work facilitating RTW does not involve the use of PDDs. While various job match models proposed by multiple groups (S. Isernhagen, 2006; C. James et al., 2014; Nützi, Trezzini, Medici, & Schwegler, 2017) indicate the necessity for both the worker capacities and job demands to be known in order to perform the match process, participants noted that the use of detailed data such as PDDs may not actually be part of the process. This could be for a multitude of reasons, such as: the belief that social, mental, or organizational issues may be the limiting factor in RTW and not physical demands (MacEachen et al., 2006); a lack of quality accurate data available to the RTW team for use in the comparison, i.e. highly variable work; or where the standard practice is not to focus on minute details and to treat the case as conservatively as possible due to the vague and general nature of a workers potential occupational restriction. Participants believe there is little value in obtaining precise data with regards to tasks, i.e. lifting/pushing/pulling/carrying when the information used as a comparator may be for example “light duties” or “limited lifting”. Given such restrictions, detail within a PDD document does not provide any usable value as it is impossible to compare tangible quantitative data, i.e. 5 lbs lift, to subjective statements, i.e. “light duties”. While detailed PDDs may help a RTW professional make their decision, they are still required to use their best judgement in order to determine if a job does or does not match the workers provided restriction profile and rely on experience to make those judgements. Others noted that for cases with vague restrictions, the default protocols typically used attempt to direct the injured worker to avoid performing the provocative and or “restricted” activities altogether during their recovery. While a conservative approach to RTW may not require the level of detail typically present in a PDDs, it is unknown if having the information available could impact their case management processes, or provide value elsewhere in the RTW process, other than structuring the workers accommodation.

The main function of PDDs within the RTW process is to serve as a tool describing the demands of the job for comparison against the capabilities of the injured worker. This finding was expected given the current body of research regarding the job match model of RTW and use of job demands information within RTW.(Gagne, 2010; D. Isernhagen, 2000; Occupational Health Clinics for Ontario Workers, 2014b; K. Sinden & Macdermid, 2014; Toeppen-sprigg, 2000) High quality PDDs provide a benefit within RTW. Not only do they allow for a reader to match a job’s demands with the capacities of the worker, but PDDs can also be used to identify what parts of a job a worker is/is not able to perform in order to inform potential job modification strategies. Job modification strategies may mitigate potential lost time for the employer, and ensure that the injured worker is still able to be accommodated while performing meaningful work within the workplace, hopefully improving RTW outcomes (Larson, Renier, & Konowalchuk, 2011). Participants who identified that they were their professional focus was occupational ergonomics were the individual who may develop the PDD document for their employer, however were usually not the individual who used the document within RTW. Participants who identified themselves as a “disability case manager” or similar title were the ones to utilize the PDDs and rarely would be the individuals who develop the documents. The “disconnect” in the process between individuals who develop PDDs and the individuals who use PDDs does allow for “specialists” to focus on their strongest skillset. I.e. a more “technically inclined” ergonomist can create a quality PDD document, while a “case manager” with a skillset that may be more focused on the “soft skills” required to navigate the disability management process can facilitate the return of the injured worker. Such a process allows for the professionals to hone their focused skillset, as opposed to being required to possess a wider range of skills that may not be as well developed. While this process allows for the “best” use of a professional’s skillset, it does open the possibility to process inefficiencies related to the communication of relevant information, as the individual who is most knowledgeable regarding the job, i.e. the “ergonomist”, is not the one ultimately making RTW decisions while using the document. Information contained within the document may be misunderstood by individuals reading the document who do not possess a similar lens or frame of reference to the information.

Although it was not directly stated by participants in this investigation, processes which contain disconnects between the individual who is developing a PDD type document and the user of the document, might ultimately lead to more useful documents, with appropriate feedback mechanisms in place. Individuals who identified themselves as “PDD developers” for their employer mentioned that they may be called upon during a RTW case to provide extra information or to clarify a PDDs information for all of the readers of the document if issues arise. If a process to review cases where “clarification” is required as the PDD documents are not clear, were to take place, it may ultimately lead to an overall more usable document. If internal parties (to the workplace) who are familiar with the work being performed and jargon typically used by the employer are unable to comprehend or utilize the information in document, there is a greater likelihood that if required, external parties (to the workplace) who may not have the opportunity to observe the job live or even be familiar with the work being performed, such as insurance carrier representatives, will not be able to understand and effectively use the information presented in the document. Documentation and review of instances where information contained within a PDD was unclear to readers from within the employer may serve as useful teaching tools in order to improve practice and ensure that the information provided in a PDD can be used effectively by all potential readers.

The participants who self-identified as being external providers of RTW/ergonomic services stated that they typically, but not always, would be the individual who would not only develop the PDD but would also use it to inform a job match for an injured worker. These individuals tended to speak more towards their experiences directly using PDDs within the RTW process as they typically possessed more direct experience from start to finish developing and PDDs to facilitate RTW. Where individuals who self-identified as a “case manager” may have had a less strong stance on the use of PDDs within RTW; participants who were an external provider of service tended to note that their use of PDDs within RTW was highly beneficial as it would allow for a more data-driven approach to RTW. While this may reflect these participants true experiences and beliefs, it is unknown how much of that belief is influenced by these individuals selling a professional service to employers providing comprehensive RTW management and ergonomic services that focus on the development of PDDs.

Shortcomings related to the use of PDD data to facilitate RTW focus on the trust readers have in the data, and how a lack of trust limits the usefulness of PDD data in RTW. The main purpose of a PDD within RTW is to convey information related to the demands of a job. Poor quality data limits the usefulness of a PDD document as the reader is unable to form a strong defensible decision regarding the suitability of a given work assignment if they do not have (reasonable) faith in the information which they are using to base their opinion. Poor quality data may come in many forms, be that missing information or information that a reasonable individual would not expect to represent the task, such as "lifting floor to waist 1000 lbs". While an error such as "lifting floor to waist 1000 lbs" may be a simple typographical error, such concerns raise questions as to the attention to detail and focus on quality as it relates to the rest of the information in the document. These documents may be a hinderance on the overall RTW process as RTW decision makers may feel the need to collect their own information, if possible, in order to obtain information, they can trust. This leads to increases in the valuable time required to manage a RTW case, as delays in the process can lead to suboptimal outcomes (Loisel et al., 2005; MacEachen et al., 2007). Internal employer costs related to the management of cases may also increase as the work required to gather information useful in RTW would need to be repeated if a RTW professional does not have a high degree of trust in the quality of information contained within a document and must collect/recollect the required information.

The use of information which is not "obviously" correct in the RTW leads to process inefficiencies as incorrect matches of a worker's capacities and the workplace demands may be made. RTW scenarios with "incorrect" job demands data may lead to prolonged recovery periods and unsuccessful RTW efforts as the worker may not be able to safely perform the duties which they have been asked, or may continue to work to the overall determent of their physical condition as they may not fully grasp the concept of "hurt vs harm" or be unintentionally (mis)guided by RTW professionals basing their judgement on incorrect information. Many RTW professionals are rightfully concerned with the information that they are using as a target to assist the worker during their recovery as relying on poor quality information may lead to less than optimal outcomes and may risk their professional reputation. The lack of standardization in the development of PDDs may play a role in the concerns raised for the use of previously collected (not by the reader/end user) information within RTW.

There is no one “best practice” when it comes to the documentation of job demands and the presentation of that information. This makes the use of previously collected information challenging as the RTW professional cannot be certain what processes were used to collect the information or what level of accuracy was deemed acceptable by the assessor. The lack of standardization, “best practice”, or even widely followed guidelines for conducting a PDD, are valid significant concerns that professionals have when they are required to risk their professional reputation. The information that is contained within a previously developed document may not necessarily be of poor quality, however it is challenging for a RTW professional to defend a decision they have made based on information of unknown provenance. Issues related to the method used for PDD information collection are also influenced by the skill of the PDD assessor. Research has shown that the information collected in a PDD is influenced by the skill of the assessor (Coffey, Vandergriendt, et al., 2016). Even if a “best practice” was adopted, the assessor skill and experience may still influence the “quality” of the final PDD document in ways that may negatively impact RTW decision. The inherent diversity of possible methods of data collection that could be accepted as a “PDD” leads to a significant issue when attempting to utilize previously collected information as there is no way in knowing how some information was collected, what level of precision was used when taking measurements, or even what level of completeness the document reflects of the job being performed. The lack of standardization is an important factor for the RTW professional to be able to explain their reasoning behind the decisions they make given the information they are provided. This is why many of the professionals who have the ability to do so employ the practice of trust, but verify, with regards to the information they have not collected themselves.

The development of a standard process or workflow for PDD development could provide an inherent level of “trust” in the information contained within a PDD document. This improvement in “trust” in a PDD document may minimize the amount of work duplication that occurs in the RTW process as there would be less ambiguity in how measurements of interest are collected. Potential reductions in work duplication may expedite decision making throughout the RTW process. RTW professionals tasked with managing the case can rely more heavily on the work (PDDs) that has been completed in the past and focus more on the tasks they are required to perform in order to facilitate the successful RTW of the worker. HCPs can also benefit from the increase in “trust” in a PDD as they can be assured that the information within the document is developed via a known process and “should” provide a reasonable level of data accuracy if/when referencing the document during their treatment of the injured worker.

The use of PDDs as a comparison tool against an injured workers restriction profile is rarely a simple exercise. An Injured workers restrictions may be provided in a manner that matches information contained within a PDD, such as “limit lifting to <5lbs”, however restrictions are commonly ill-defined and provided using vague language such as “light duties” or “limit use of arms”. While detailed tools such as FCE/FAE’s are available in order to determine a worker’s capabilities, often times the worker does not complete such an assessment due to availability, time and costs associated. Often times a worker is assessed by their HCP who will make recommendations on RTW based on their professional judgement and assessment of their patient (injured worker) (Viikari-Juntura et al., 2012). Without the resources available to make specific recommendations for RTW, such as those determined by a FAE/FCE, HCP’s are limited to the detail within the recommendations they can provide. Ill-defined restrictions make for a challenging job match as the RTW professional is required to interpret the meaning of functional restrictions such as “light duties”. PDD documents that only provide definitive information, such as “x lifts per minute” or “lift y lbs box” without additional context do not provide any means for RTW professionals to make judgement calls as to how they can apply the information against vague or ill-defined restriction profiles. RTW professionals are tasked with attempting to determine the meaning of ill-defined restrictions, and may be required to attempt to clarify such restrictions in order to ensure that no offered work violates the restriction profile. In cases were the workplace RTW professional is required to reach out to the treating practitioner, it is likely that both the workplace parties and the worker's HCP most likely do not share a common skillset (Soklaridis et al., 2011), and also likely do not share a common perception of the work being performed. Communication difficulties between parties also becomes a challenge as it typically occurs in one direction, physician (HCP) to patient (employee) to employer. Further compounding issues, communication between parties is primarily impersonal in nature (Pransky et al., 2004). This makes conversations between HCPs and workplace parties difficult as they are most likely not going to view the problem at hand through a similar lens. The addition of information within a PDD to frame or contextualize the work being performed may provide an overall usability benefit, not only for the RTW professional, but also for any HCP that may have a minimal understanding of the work their patient is performing. The addition of information to frame or contextualize may also serve as the foundation of a conversation between the workplace parties and the HCP, by providing an anchor point as to where both parties can begin their discussion.

The inability to reliability determine what information ill-defined restrictions attempt to convey is one factor that leads to the highly conservative nature of RTW. It is in every employers best interest not to ask their employee to work outside of their capacities and to provide suitable accommodations that will allow for a quick recovery, and not prolong the period of reduced work capacity (Buys, 2019; Collie et al., 2018). It is not possible to develop a PDD document that may align with an unknown frame of reference, i.e. classify what jobs a specific HCP may consider "light duties", as that moves the document from a focus on description to a focus of analysis. Having an understood or predefined criterion used to inform efforts at translating tangible job information may lead to a reduction in miscommunication between practitioners and may improve RTW outcomes (Pransky et al., 2004). If that is not possible, it may be a beneficial practice to proactively provide injured workers with copies of PDD documents upon first reporting an injury to the employer, such that the employee is able to review the document with their HCP during assessment to ensure that the all parties are aware of what job demands exist, and how their decisions may potentially impact accommodation efforts.

While it may be difficult to easily match a job's required demands with the capacities of the injured worker, making a perfect match may not be absolutely necessary. The exactness of the information that RTW professionals may develop/have with regards to the physical job demands matters quite little in the context of the overall goal of returning an injured worker back to their job. Absolute accuracy and detail in a PDD document, it is argued by many participants in this investigation, is not required to be successful in RTW. Accuracy and detail are not required as there is (usually) a good deal of uncertainty with regards to the employee's capability, as information provided by a treating HCP is hardly ever as exact as "do not exceed 30 degrees of neck flexion" and may be as simple as "limited X", or "additional breaks for rest" (Toeppen-sprigg, 2000). While the restriction profile provided may be ill-defined or overly vague, when comparing worker capacities and work demands, the least precise measure will dictate the requirement for precision of the entire job match exercise. While typical PDDs may not serve as easy to use tools offering a perfect comparison between job demands and all possible worker restrictions, it may not be critically important given the variability in all of the information used in the comparison. As long as the employer is able to provide work that can be deemed suitable given a restriction profile, the RTW could be considered "successful". Depending on the specific policies and procedures, identification of "vague" occupational demands outlined in a "reasonably accurate" PDD may be completely acceptable given vague worker capabilities.

PDDs should be structured so that job demands can quickly and easily be indexed against a worker's capabilities. Participants noted summary style PDD documents were useful for quick use during the process of job matching against worker capabilities in order to provide suitable work, however, did not provide detailed information at a task level useful in job modification. While participants stated their desire for both types of information, summary data and a task-by-task breakdown, many voiced a preference for a task-by-task breakdown of job demands vs. an overall job summary, as this would allow for “easier” use during job modification efforts as problematic tasks can be easily identified. A summary style document would be useful in quickly identifying whole jobs that may or may not be suitable, however this format does not lend itself well to job modification efforts as individual elements can be difficult to highlight when reading through the document. PDD documents that provide both types of information, such as a document providing a detailed task by task breakdown along with a concise “summary” of values of interest, e.g. maximal weight lifted, maximal walking distances, overhead work, etc., could provide the reader with much, if not all, of the information they require, and may not significantly increase the workload during PDD development. The addition of both summary and detailed task information would allow the PDD to provide an increase in value over more scenarios in the RTW process. The document could be used in the early stages to quickly determine overall suitability, and also would be able to provide the detail required with attempting job modification strategies.

PDDs in their current format tend to be poor comparators against workers “typical” restriction profiles. There is no one set standard for PDD document development. This makes the tasks of utilizing a PDD document somewhat challenging as the reader of the document does not know what types of information they will be provided or how that information may be presented to them. For example, a PDD document may provide the reader with summary information of factors of interest, such as maximal loads lifted, or specific maximal joint angle required during the job cycle by an observed worker. PDD documents may also provide general ranges of factors of interest such as movement frequencies (i.e. given in rare/occasional/frequent/constant) or strength requirements (i.e. limited/light/medium/heavy). Neither type of document lends itself to easy comparisons with typical restriction profiles. In documents with a fine level of detail, the reader of the document may become overwhelmed with the quantity of information they are required to read in order to obtain the information they desire. Documents with an excessively crude level of detail may not provide the necessary information a RTW professional requires in order to make useful decisions. While it is impossible to provide information in a manner that makes for an easy comparison against all possible types of information provided as possible restrictions, incorporating both fine detail and the general context in which the information may be framed could aid in overall usability. An example could be a job requiring the lifting of a 12 lbs box every 3 minutes, in the section outlining job demands the 12 lb lift could be noted along with the NOC classification(Minister of Industry, 2012) of the work given the demands, i.e. light, medium, or heavy work. While it may not solve all concerns, the addition of more contextual information may aid in overall usability of the information in the document. It is most likely not possible for all employers to be able to provide their RTW professionals with access to the most up-to-date research to reference when justifying RTW decisions related to restrictions and job suitability. However, developing PDD documents that cite references to the sources of information used to base their decisions, or even provide a copy of openly available information, such as the NOC definitions of strength ratings and frequency, could increase overall usability of the PDD document as all readers would be able to understand how the document could be used to inform a RTW decision and may address concerns of communication difficulties between parties, as discussions may now be framed based on tangible information available to all parties in the process.

The main focus of the PDD document is to describe all of the required information, while a quality document will need to clearly communicate the information provided, the readability/usability of a document is usually not the main focus when creating a PDD document. A single complex document, while useful for a trained individual, may be too complex for most readers of the document. A document that was developed with readability and usability in mind for a wide range of users might contain both fine and gross detail sections which the reader may choose to use given the requirements at the time. Such a document would provide the basic information that is required in an easy to comprehend format for nearly all readers, and could also provide the complex information that is useful to more skilled readers/RTW professionals.

Overall however, it appears that participants in this investigation had a tendency to default to a preference of document structure/content of which they were familiar when questioned on their preferences in a PDD type document, using phrases such as “the format that we use”, or “We have a…”. It is unclear how much of that preference is driven by a lack of exposure to different structures and formats of which participants are not familiar, or by how well the documents they typically utilize fit within their own organizational processes leading to an ease of use via experience. It is unknown if the participants professional history has any bearing on their preference of document, as many of the participants in this investigation primarily service industries with highly dynamic, unstructured work environments. Further work examining participants whose professional experience services more structured work environments, i.e. industrial manufacturing, may provide further insight and better inform future development of PDD document structure.

While the ePDD cannot replace the current practice for PDD development, it does provide some insight into how current PDDs may be modified in order to improve overall usability in RTW. Participants believed that the ePDD could potentially be a useful addition to the RTW process, however in the current format found it to be cumbersome and potentially detrimental to the process. Much of the information presented in the ePDD document is relatively novel in terms of providing it within a PDD. As noted previously, participants expressed a preference for document structures/styles of which they were familiar, is unknown if continued exposure to the novel information provided in the ePDD, such as joint angle summaries, might provide a benefit to RTW practice. The ePDD in its current format was designed to easily convey joint angle measures, and mobility, percentage of work cycle spent in defined reach zones, and a graphic representation of the distribution of forward reaches and hand travel distances only (Ward et al., 2015) as these factors were noted by the team developing the tool as part of their internal RTW process. The ePDD was not designed to address any concerns that may arise in current RTW practice with regards to the use of PDD data. It could be a possibility that the team which provided guidance during the development of the ePDD does not experience many of the same issues, or use PDDs in a similar manner as the participants interviewed in this investigation. This may be due to the variation in training, education, and professional background of individuals who practice RTW (Bohatko-Naismith, Guest, Rivett, & James, 2016; C. James et al., 2014; W. Shaw et al., 2008), or this may be due to the differences in RTW practice in the automotive sector in which the participants in this investigation had limited experience.

As the ePDD provides descriptive information that is typically not provided in current RTW practice, as well as analytical information that is most likely never used in RTW, participants view that the ePDD may serve at best a supplementary role should not come as a surprise. With concerns related to the diversity of experience/training that individuals who participate in RTW have, providing analytical biomechanical information would most likely add to the informational overload that may occur reading a PDD type document. Even if the addition of analytical information within a PDD did not raise more questions, the addition of analytical information, moving the document away from being a "physical demands description" and towards a "physical demands analysis" does not serve the main purpose of the document in current RTW practice, serving as a comparison vehicle against a workers restriction profile. The addition of analytical information, while beneficial to the right user, begins to detract from the overall goal of what the document is attempting to achieve and risks the document becoming a "jack of all trades, master of none". If the overall focus is to develop a tool that is functional with a RTW context, providing a wide array of "relevant" information does not provide value in the RTW process if the information is not usable by the reader.

The participants in this investigation, on average, possessed a significant amount, 14.3±8.3 years, of experience facilitating RTW. Many of the participants found it difficult to make use of the information that is being provided in the ePDD. If the eventual goal is to utilize the ePDD in a RTW context as a stand-alone tool, much of the information needs to be presented in a manner more easily digestible by a novice audience, and most likely in a manner similar to current PDDs to increase immediate usability and acceptance in the RTW community.

Participants believed that the context provided by the graphic nature of the ePDD was the strongest asset of the ePDD over and above a traditionally developed PDD. Visuals are a good way to convey information quickly and efficiently (Dunlap & Lowenthal, 2016; Lyra, Isotani, Reis, Marques, & Pedro, 2016), however much of the information in the ePDD, while useful to the right reader, is not very useful in RTW given the current format. The video which accompanies the ePDD document is a useful addition in order to provide the context required to understand the job. In many circumstances there is no benefit of a video of a (good) digital simulation over and above a video of the job being performed by a person in the workplace. In certain simulations provided to participants visual errors were purposely presented to participants in order to gauge their feedback. Without providing contextual information as to what should occur in the videos, there was a noted loss of 'trust" in the ePDD to describe the demands of the job with "errors" in the video, as the video is critical in providing the necessary context that readers of a PDD need to frame the information. It is unknown if there is an acceptable amount of "error" or "approximation" that may not influence the viewers opinion of the video while still conveying the required information. With the significant time and cost (software costs, time of trained professional) required in order to develop "realistic" (error free) simulations given the current state of the Tecnomatix Jack tool for developing the ePDD, it is not financially viable to use the ePDD in order to develop simulations identically mirroring a live worker when recording a video is quick and carries a negligible cost. It is unknown if the addition of some narrative information to frame the data in the ePDD would lessen the role that the video plays in information transfer, improve overall usability of the ePDD, or minimize the overall effect of visual errors.

Future work should examine if there is a point of diminishing returns with regards to obtaining jobs demands data from videos (of live persons and of digital manikins) in order to determine what exactly the viewer is gathering from the observation. It is currently unknown if an assessor of job tasks, be it live or via video, require the necessity of observing an entire task from beginning to end, or if it is possible to provide short focused segments of interest, or even pictures, along with narrative information and gather the same overall information. For example, if there was an observer watching a scene with a worker, a box on the floor and a shelf, does the observer require to see the worker pick up the box from the floor and place the box on the shelf, or is the observer able to interpolate what occurs if only provided images of the worker obtaining the box, and placing it on the shelf are provided, knowing that goal is to place the box on the shelf. Does the reader's "trust" in the final document differ if being presented with pictures, short video clips, or a video of an entire job cycle? Is possible to provide short videos of tasks of interest and convey the same information as a video of an entire job cycle? If it is possible to minimize the amount of data presented to the reader, It would minimize the overall cost, both in time and money for a simulation developed PDD, as there would be significantly fewer opportunities for the simulation to develop "visual errors" that may negatively impact the end product. This may provide developers of digital human model simulations with the ability to focus their time on the areas of the job where concerns are most likely to be found, and ignore components of job tasks where questions are less likely to arise but are still challenging for the current software products, such as walking between stations or turning a mannikin around in place.

It is unlikely that the current form of the ePDD will replace the traditional PDD. There is important information typically found in a PDD that is missing in the ePDD. The ePDD document lacks any contextual information content that may be used to frame the provided information. While participants in this investigation raised concerns about too much and too little narrative information in a PDD, some information is required in order to understand and frame the provided information in the context of the work being performed. Being informed that an individual is required to move tens of thousands of pounds of product a day may make a job sound extremely physically demanding. However, if the description also included that the worker would be driving a forklift to move the product, that completely changes the lens through which the reader views the job.

During the interviews, participants routinely questioned the interviewer on information that was in the document, however not clearly highlighted, such as task frequencies. The ePDD document itself is structured in a manner to present the information primarily on a "per cycle" basis. A common point of concern among participants is the requirement for task frequency information to better inform their decision making in RTW. While task frequency information is provided, it is not highlighted and as such, appeared to be missed/overlooked by most of the participants in this investigation. The ePDD as an overall tool is in its infancy stage, and does not provide the information required in a manner that current RTW professionals are able to use without significant training or instruction. While it does provide some benefits over and above current PDDs, such as the addition of visuals, the benefits provided do not outweigh the challenges that are created by providing the information in a manner that is not common, given current practice.

For this investigation participants were asked to review the documents provided via email when confirming their participation in the study for ~15 minutes prior to the interview in order to familiarize themselves to the content and structure of the documents. Many participants confessed not reviewing the documents prior to the interview and informed that interviewer they would review the documents mid interview instead. While this does not impact the ability of the ePDD to be used in RTW, it does impact the depth and quality of the information provided by the participants. The lack of review (experience with the ePDD) does call into question the quality of information provided related to the ePDD as it relates to questions focused on details of the document, such as information content, however less so as it relates to more general information such as visual presentation. If future work is to continue the examination of the ePDD, it would be beneficial to structure the work in such a format that participants were provided dedicated time for review during the investigation, in order to increase familiarity. This does not call into question the information provided as it relates to the first two research questions, as the participants in this investigation possessed sufficient experience facilitating RTW in order to be able to provide information rich answers.

Recommendations for PDD Development

This investigation uncovered a significant amount of information as it relates to the use of PDDs within a RTW context. While participants overall noted a preference for information/styles/structures of which they were familiar and had experience using, overall the information can be synthesized into meaningful recommendations for the development of high quality PDDs. The information content of the PDD should contain all physical and environmental demand components of all essential and non-essential tasks of a job (Occupational Health Clinics for Ontario Workers, 2014a). While summary information, i.e. heaviest load lifted, maximal reach required, provides useful information when quickly reviewing a document to determine suitability, it does not provide the detail required when examining specific job tasks. A detailed task-by-task description of the job is useful when attempting to utilize a PDD for specific task suitability (i.e. for job modification), as well as aids in highlighting issues within jobs that may be useful outside of reactive RTW (i.e. hazard identification), however is less beneficial for quick review of job demands given the amount of information provided. The inclusion of a section of the PDD consolidating summary information for quick review would be a beneficial supplement to a task-by-task breakdown of the job as it would provide the reader with a time savings when reviewing a document if fine detail is not required. The relevant objective information in the PDD should be accompanied by some form of information that provides context in order to frame the job demands information(i.e. if a job task requires a worker to lift a box from 60cm from the floor to a height of 150 cm, at a constant forward reach of 35 cm, narrative information such as “the worker lifts a box from the floor to a shelf while standing behind a barrier”). The addition of pictures capturing the workers relevant posture during the task would further increase the ability for the reader to frame the information and gain understanding of the task attempting to be described, for example capturing a picture of the hands when performing fine finger work compared to a picture of the worker standing at a workstation.

In order to facilitate the use of the PDD as a comparison tool against a worker’s restriction profile it would be beneficial to document and describe the work in a manner that is easily comparable to common worker restriction profiles, i.e. a Functional Abilities Form(WSIB, 1997), such as walking, standing, sitting, bending, crouching, and use of the upper extremity, etc. Details provided regarding the work task over and above that in a Functional Abilities Form would make the PDD more useful in challenging situations such as a prolonged recovery, it would be beneficial to describe the postures/timings/frequencies of motion of relevant body segments for the work tasks performed (i.e. what is the range of motion for the shoulder for a given task?, number repetitions of shoulder motion per minute in order to complete the task?, etc.) as this information may provide value to stakeholders in the RTW process such as HCPs.

Objective measurements should be taken as much as possible in order to quantify the job being performed. These would include measurements of weights lifted and carried, forces to push/pull objects, forward distances and height from the floor/standing surface for reaches. If variations exist in measurements of tasks performed the inclusion of measurement qualifiers such as ranges, averages, and most commonly performed would increase the validity of the description of the task.

Providing information as to how information was collected would aid in minimizing some of the concerns interview participants noted with reading documents created by someone other than themselves. Including information to further describe measurements that contain some subjectivity, such as postures used by workers (i.e. how tall the was the observed worker, what time of year/day/shift was the data collected and do differences occur over the course of the year/day/shift/etc.) might aid concerns. Providing information describing work practices would increase the validity of a PDD. Describing in the document how the work can be performed, e.g. with and without a specific tool, could address concerns related to the quality of information in a PDD. Factors to consider when developing a PDD document include: how is a task performed?; does the work method change (e.g. different parts on a production line)?; and are possible differences captured in the description of the task?. This information could provide more context to the data, as well as potentially addressing concerns of data quality if the document is to be validated at a later time, as different workers may prefer to perform a job slightly differently, or a job process may change over time, leading to the same end goal however requiring completely different physical demands. Providing the contextual information of how the job is completed would allow for the simple validation of the document as differences/changes could be quickly identified and new data captured if necessary. Providing information as to the protocol behind collecting information could also minimize the questions that relate to PDD data quality, e.g. explaining in the document that measurements of force were taken with a specific tool, under specified conditions, using a defined protocol could mitigate any questions of "how was this data collected?" while also increase the "trust" readers have in the document. Trust could be increased as it could be demonstrated that the developer of the document was performing a structured, reproducible process that could be validated if necessary.

To improve the validity and quality of a PDD it would be beneficial for the document to be reviewed by an expert prior to publication. Having a workplace expert (i.e. worker, supervisor, manager etc.) review a document for any required changes helps ensure completeness of the document, and aids in the credibility of the document as it relates to its ability to describe the work being performed.

Limitations

A significant limitation of this investigation lies with the recruitment protocol. By design the study population is highly heterogenous, with 84% of the study population being comprised of Kinesiology graduates, and over 50% of the study population functioning in a professional capacity self described as an "ergonomist". Only two participants identified as having an educational background that was not "kinesiology", however those individuals all identified as having a background in physical therapy. Participants identified as PTs all practiced as employer representatives, and were not actively treating patients clinically. The study group was highly homogenous, with many of the participants also sharing similar professional backgrounds. None of the participants informed that their primary professional focus is to service employers whose work is highly standardized and cyclic. Seven (7) of the participants identified themselves as consultants for hire, two practiced in the energy sector, two individuals in material handing, seven in healthcare, and one participant noted their focus to be the insurance sector. The only individual who noted their professional focus is to advocate for the workers in RTW is the individual who identified their focus to be insurance, all other participants noted their role is to advocate on behalf of the employer in RTW matters.

All of the individuals who did not identify as consultants for hire made some reference to the PDD documents they typically use, and how the current structure of the ePDD would not "fit" their organization due to the rigid nature of the simulation which the ePDD is based compared to the dynamic nature of the work they typically support. With a narrow range of professional experiences, it is likely that the information collected may not reflect the general opinion of ergonomist or kinesiologists that practice in RTW as a whole. It most likely would not reflect the experiences of individuals who primarily service employers in the manufacturing sector, specifically automotive, which contain a large portion of their workforce in highly structured and repetitive jobs. None of the participants in this investigation noted a professional background in automotive assembly, only the individuals who identified as consultants noted any experience in industrial manufacturing environments. The ePDD was developed in conjunction with an employer in the automotive manufacturing sector, whose work is highly structured and repetitive. It is likely that the information uncovered during this investigation, while still applicable to overall PDD development, may not be the most beneficial to an audience that is attempting to improve a tool for used in a highly structured and repetitive work environment. It would be beneficial to gather information from participants who have experience in industrial manufacturing environments as these individuals may be able to provide insight into how the RTW process may proceed in highly structured work environments, could provide useful insight into possible avenues for ePDD improvement.

In order to obtain a more relevant look at how RTW may be handled for large manufacturing environments, it would be useful to further collect data from individuals whose professional focus is to service highly structured work environments, specifically automotive manufacturing. These are the individuals who are most likely to utilize an ePDD, as the current capabilities of the tool limit feasibility to simulating structured work. To gather more information as to how PDDs are used overall in RTW, it would be beneficial to include members of other professional groups, such as physicians, other practicing HCPs treating injured workers, and other groups identified by participants such as human resources professionals on their experiences facilitating the return of injured workers. Gathering experiences from individuals that focus specifically on advocating for injured workers, such as union representatives and members of worker advocacy groups would provide another point of view that was not very well explored given the population of this investigation. Only one individual in this investigation noted their role to be advocacy for the injured worker. It would be beneficial to gather more insight from other individuals who work for insurance carriers, and those groups noted above, to gain more insight into how RTW is experienced from a viewpoint other than employer representatives. While advocates and representatives are an important part of the RTW process, a significant missing component in this investigation, is the experiences of injured workers and how they may have experienced the RTW process as it relates to; the work demands; the provision of work, modified or otherwise; and how that information is documented and conveyed to parties throughout their RTW process .

One of the major limitations with regards to the investigation as it related to the examination of the ePDD was that many of the study participants noted verbally to the interviewer that they either did not review the pre-delivered materials as requested, or gave the material a quick read in order to "fulfill" the request to review the material before the scheduled interview without performing a through review of the information. Material was provided to the interviewee at the time of scheduling, which ranged from 2-14+ days in advance, participants were asked to review the documentation for ~10-15 minutes before the interview in order to familiarize themselves. Some participants were prepared for the interview with questions they had regarding the materials, conveyed an engagement with the interview topic, and provided answers with seemingly more richness and detail. These participants tended to ask less questions that may be answered by a quick scan of a page, such as "what are the units of this measurement?" and more questions that exhibit deep through about the topic such as "how is this calculated?". Participant's who admitted a minimal or no review before the interview provided shorter, less detailed answers, presumably as they were attempting to process the novel information and provide answers to questions simultaneously. This was indicated by participants asking questions such as "where would I find "X" in the document?", with "X" referring to information that is conspicuously titled/labeled within the document such as “weights lifted”. A small number of participants did have difficulty with the both the traditional PDD and the ePDD documents, as they admittedly were not familiar with the multi-sheet format of the excel files in which both files were presented. These individuals were led through the files as their experience with technology admittedly was somewhat limited, and were not expecting aa file containing more than one spreadsheet of information. It is possible that with more detailed instructions beforehand some of these issues may have been avoided. It is also possible that these individuals may constitute those who may be common in the RTW process at all levels, these and similar issues might possibly exist for many of the potential readers of the ePDD. A manner of informing the reader as to how the document is structured, i.e. instructions for use, may be beneficial for the use of the ePDD, if a total redesign is not performed. The demonstrated lack of familiarity with the document calls into question the quality of the information provided in some of the interviews. While some interview participants demonstrated an understanding of the document, many did not. It is difficult to draw conclusions related to questions requiring more familiarity with the material such as how the information in the document should be presented or changes to be made in the document if a significant portion of the study population had difficulty gathering information from the document in its current format given their lack of familiarity. It is unknown if more time for review, or explicit instructions for use sent along with the documents would impact the answers provided by these participants.

Conclusion

This study gathered thoughts, opinions and beliefs of RTW professionals on their use of PDD data within the RTW process. It also presented a novel manner of developing a PDD from a digital simulation of work being performed. The use of PDDs within the RTW process was not consistent across participants and varied widely. While PDD information may be useful while attempting to facilitate the RTW of an injured worker, some participants noted that they typically do not require an in-depth PDD document due to the variability in job demands and highly conservative nature of their employers RTW process. Other participants stated that detailed PDDs serve a vital purpose in their role to ensure injured workers remain with their employer performing meaningful work. Concerns were raised with what information is contained within the PDD and how that information is presented to the reader. Documents that may be too simple or too complex may not be useful and may actually be detrimental to the RTW process either by not providing the required information or by leading to the reader's confusion through an overload of information when attempting to read the document. How the information within a PDD may be presented was noted as a issue related the utility of PDDs due to the lack of standardization in document development. Participants were concerned that the lack of standardization may lead to difficulties in understanding how the information was gathered, as one RTW professional may gather information using a specific process, another RTW professional may perform a completely different process which may lead to differing results. Participants did not identify one "gold standard" with regards to the document structure or information content. Professionals interviewed voiced a preference for documents they were most familiar and were comfortable using given their experience.

When examining the novel method of PDD development (ePDD), the initial hypothesis of this investigation was that participants may see value in the novel method as a means of overcoming many of the issues that exist with PDD development. This novel method was found to provide an excellent use of visuals that, generally communicated the information relatively effectively. Specially noted as useful was that addition of video to the document outlining job demands, however it was noted that the video of the simulation would not provide any more value over a video recoded of a live work task. However, participants found that this novel method was difficult to comprehend overall. The document does not provide all of the information useful within a typical RTW case, provides some information that may confuse even relatively knowledgeable individuals, and is not structured in a manner that would facilitate the ease of its use within a typical RTW process. Participants found that this novel method of describing job demands, in its current form, would be useful as a supplement to traditionally developed documents, however would not be useful as a stand-alone tool in the RTW process without major revision. While information was uncovered related to the novel method of PDD development (ePDD), it should be noted that a significant number of the participants expressed they did not spend sufficient time familiarizing themselves with the ePDD, and demonstrated a lack of understanding of the document through a lack of richness in their answers and requesting clarification and direction to explicitly stated information within the documents. While participants may have found the ePDD to provide value with the addition of visual and graphical information, it is unknown if a study population who is more familiar with the ePDD may reach the same conclusion. It would be beneficial to investigate if the ePDD in its current format would be able to provide vale in RTW with other groups of interest (i.e. those focused in manufacturing RTW), as they may find benefits that were not uncovered in this investigation. Further research into the use of the ePDD is needed to provide stronger evidence for of its utility in RTW practice. Further research into the use of PDD data in RTW is required in order to gather more information regarding what RTW professionals require within the process, and how simulation-based documents may be able to address any gaps that may exist.

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Appendix A – Interview Guide

Interview Guide – Kinesiologists

1. What role do you play within the return to work process?

   Probes: How much autonomy does you role provide you? How collaborative is the decision making process in your clinic? Who, if anyone, do you reach out to for assistance in making decisions?

2. Tell me what the process is in your practice/clinic with regards to the use of physical demands descriptions in the return to work process?

   Probes: Are there any circumstances in which the process changes? Is there anything that you require from the individual in question? The employer? How does this process change throughout the course of treatment?

3. Are there any barriers or shortcomings that exist with respect to the current process of PDD use within the RTW process?

   Probes: Why do you believe these exist? What might you do to mitigate these issues? How would the removal/remediation of these issues change your treatment process?

4. What kind of variation have you encountered with respect to physical demands descriptions (PDDs) (analyses) a patient/employer has provided you?

   Probes: what information did it provide? What information was missing? How was the document structured? What did you find to be a positive of the layout? Negative?

5. Specifically with respect to traditional PDDs, what information do you first focus on within the document?

   Probes: What about that information makes it so important for you? What is the second piece of information you look for? Third? Etc…? Is there any information that you believe does not provide value?

6. Is there any information you believe would be of benefit to you when working on a RTW case that you are typically unable to obtain with regards to the physical demands of an individuals work?

   Probes: Why do you believe this information is important? What changes would that allow you to make with respect to you treatment decisions?

7. Specifically with respect to the digitally created PDDs, what information would you first focus on within the document in its current format? Does the accompanying video provide any value to you?

   Probes: What about that information draws you attention? What is the second piece of information you look for? Third? Etc…? What do you believe is the value of this information? Is there any information that you believe does not provide value? What about the video provides/lacks value? What would change that?

8. If there was anything that you could change about the information presented in the digitally created PDD what would that be?

   Probes: Why? How would this make a difference for you?

9. Examining both a traditionally developed PDD, and a PDD developed from a digital simulation of the job, in your opinion do these two document differ in utility? If so, how?

   Probes: What causes this? Do you prefer one over another, if so, why? What might limit the usefulness of either document in your clinic?

10. Is there something that we forgot to discuss or that you would like to add?

Interview Guide – Ergonomists

1. What role do you play, if any, within the return to work process?

   Probes: What is your specific function within the return to work process? How much autonomy does you role provide? How much are you able to collaborate with other professionals during the process, ie. Engineers, health and safety representatives etc? Who, if anyone, do you reach out to for assistance in making decisions?

2. What barriers have you encountered when working through a return to work case related to the development or use of a PDD?

   Probes: What caused the barrier? How did you overcome this barrier?

3. Explain your process for conducting a physical demands description

   Probes: Are there any circumstances in which the process changes? Is there anything that you require from the employee performing the job? The employer (if consultant)?

4. Are there any barriers which you (typically) face while conducting a physical demands description?

   Probes: Why do you believe these exist? What do/might you do to mitigate these issues? How would the removal/remediation of these issues change your PDD process?

5. What kind of variation have you encountered with respect to physical demands descriptions (PDDs) you have come across in the past?

   Probes: Were they any that stood out as exceptionally well designed/constructed? Exceptionally poor designs? What information did it provide? What information was missing? How was the document structured? What did you find to be a positive of the layout? Negative?

6. Specifically with respect to the PDDs, what are your thoughts on how the document is used within a return to work setting?

   Probes: How do you believe the document presents itself? Is there information that you believe is more or less important than the rest in this document? What about that information makes it so/not important to you?

7. Tell me what information you would like to have when conducting a PDD that you are unable to obtain within your current capability?

   Probes: Why do you believe this information is important? Would that allow you to make any changes to your assessment, aside from the added information?

8. Specifically with respect to the digitally created PDDs, what information would you first focus on within the document in its current format? What value does the video provide?

   Probes: What about that information draws you attention? What is the second piece of information you look for? Third? Etc…? What do you believe is the value of this information? Is there any information that you believe does not provide value? IS there anything that you would remove or believe provides no value to the end user?

9. Examining both a traditionally developed PDD, and a PDD developed from a digital simulation of the job, in your opinion how do these two document differ in utility?

   Probes: What causes this? Do you prefer one over another, if so, why? What might limit the usefulness of either document in your clinic? Do you see any value in the digitally created PDD

10. If there was anything that you could change about the digitally created PDD what would that be?

    Probes: Why? How would this make a difference for you?

11. Is there anything regarding the process of the creation of the digital PDD that you would like clarification on?

12. Is there something that we forgot to discuss or that you would like to add?

Appendix B – Gatekeeping Email

OKA

UNIVERSITY OF WATERLOO

FACULTY OF APPLIED HEALTH SCIENCES | Kinesiology
519-888-4567 | fax
519-885-0470
uwaterloo.ca/kinesiolo
gy

OCCUPATIONAL BIOMECHANICS & ERGONOMICS LAB

Date

Dear ___ :

This letter is a request for *The Ontario Kinesiology Association's* assistance with a project I am conducting as part of my Master's degree in the Department of *Kinesiology* at the University of Waterloo, Ontario, under the supervision of Dr. *Steven Fischer.* The title of my research project is "Evaluating the Prospective Benefits of Physical Demands Description (PDD) Data Created from Job Simulations".

The purpose of this study is to investigate the use of PDD within a return to work context, uncovering shortcomings of the current process, exploring the possibility of utilizing digital human modeling technology as a means of overcoming the shortcomings identified, and gather kinesiologists attitudes regarding possible changes to the current use of PDDs as well as changes to the proposed digitally created PDDs in order to maximize the utility and usability of these tools. Knowledge and information generated from this study may help other researchers as well as practitioners in further developing more useful PDDs.

It is my hope to connect with kinesiologists within the Province of Ontario to invite them to participate in this research project. During the course of this study, I will be conducting focus group interviews with kinesiologists, practicing ergonomists, and return to work specialists to gather their thoughts, opinions and criticisms regarding PDDs both created in a traditional manner as well as PDDs from digital simulations. At the end of this study the publication of this thesis will share the knowledge from this study with other kinesiologists, and kinesiology researchers.

To respect the privacy and rights of the *Ontario Kinesiology Association* and its participants, I will not be contacting the members directly. What I intend to do, is provide the *Ontario Kinesiology Association* with a recruitment email message to be distributed by the *Ontario Kinesiology Association* at their discretion. Contact information for me and my advisor will be contained in the message. If a member is interested in participating they will be invited to contact me*, Nicholas Patrick*, to discuss participation in this study in further detail.

Participation is completely voluntary. All participants will be informed and reminded of their rights to participate or withdraw before any interview, or at any time in the study. Participants will receive an information letter including detailed information about this study, as well as informed consent forms.

To support the findings of this study, quotations and excerpts from the stories that may be used will be labelled with pseudonyms to protect the identity of the participants. Names of participants will not appear in the thesis or reports resulting from this study. Participants will not be identifiable, and only described by general descriptors, i.e. number of years practicing and area of specialization etc.

If the *Ontario Kinesiology Association* wishes the identity of the organization to remain confidential, a pseudonym will be given to the organization. All paper field notes collected will be retained locked in my office and in a secure cabinet in the *Department of Kinesiology* at the University of Waterloo. All paper notes will be confidentially destroyed after seven years. Further, all electronic data will be stored indefinitely on a secure University of Waterloo owned and operated server, with no personal identifiers. Finally, only myself, my advisor, *Dr. Fischer, and other laboratory researchers* in the Occupational Biomechanics & Ergonomics Lab in the *Department of Kinesiology* at the University of Waterloo will have access to these materials. There are no known or anticipated risks to participants in this study.

I would like to assure you that this study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee(ORE #22792). However, the final decision about participation belongs to the *Ontario Kinesiology Association.*

If you have any questions regarding this study or would like additional information to assist you in reaching a decision about participation, please contact me at [phone number] or by *email npatrick@uwaterloo.ca*. You may also contact my supervisor, *Dr. Steven Fischer* at *519-888-4567 x30368* or by email *steven.fischer@uwaterloo.ca.*

I hope that the results of my study will be beneficial to the *Ontario Kinesiology Association*, as well as the broader kinesiology research community. I very much look forward to speaking with you and thank you in advance for your assistance with this project.

Yours sincerely,

Nicholas Patrick R. Kin
Master’s Candidate
Department of Kinesiology
University of Waterloo

Steven L. Fischer, PhD, R. Kin, CCPE
Assistant Professor
Department of Kinesiology
University of Waterloo

Organization Permission Form

We have read the information presented in the information letter about a study being conducted by *Nicholas Patrick* of the *Department of Kinesiology* at the University of Waterloo, Ontario, under the supervision of [name of supervisor] at the University of Waterloo. We have had the opportunity to ask any questions related to this study, to receive satisfactory answers to our questions, and any additional details we wanted.

We are aware that the name of our organization will only be used in the thesis or any publications that comes from the research with our permission.

We were informed that this organization may withdraw from assistance with the project at any time. We were informed that study participants may withdraw from participation at any time without penalty by advising the researcher.

We have been informed this project has been reviewed by, and received ethics clearance through a University of Waterloo Research Ethics Committee and that questions we have about the study may be directed to *Nicholas Patrick* by email *npatrick@uwaterloo.ca* and *Dr. Steven Fischer* at *519-888-4567 x30368* or by email *steven.fischer@uwaterloo.ca.*

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Nicholas Patrick R. Kin
Master's Candidate
Department of Kinesiology
University of Waterloo

Steven L. Fischer, PhD, RKin, CCPE
Assistant Professor
Department of Kinesiology
University of Waterloo

We agree to help the researchers recruit participants for this study from among the members of *The Ontario Kinesiology Association.*

□ YES □ NO

We agree to the use of the name of *The Ontario Kinesiology Association* in any thesis or publication that comes of this research.

□ YES □ NO

If NO, a pseudonym will be used to protect the identity of the organization.

Director Name: ____________________________________ (Please print)

Director Signature: _________________________________

Board of Directors Representative Name: ____________________________________
(Please print)

Board of Directors Representative Signature: ________________________________

Witness Name: ______________________________________ (Please print)

Witness Signature: __________________________________

Date: ___________________________________

ACE

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Yours sincerely,

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We were informed that if we have any comments or concerns with in this study, we may also contact the Director, Office of Research Ethics at (519) 888-4567 ext. 36005.

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Steven L. Fischer, PhD, RKin, CCPE
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University of Waterloo

We agree to help the researchers recruit participants for this study from among the members of *The Association of Canadian Ergonomists.*

□ YES □ NO

We agree to the use of the name of *The Association of Canadian Ergonomists* in any thesis or publication that comes of this research.

□ YES □ NO

If NO, a pseudonym will be used to protect the identity of the organization.

Director Name: ___________________________________ (Please print)

Director Signature: ________________________________

Board of Directors Representative Name: ___________________________________
(Please print)

Board of Directors Representative Signature: _______________________________

Witness Name: _____________________________________ (Please print)

Witness Signature: _________________________________

Date: _______________________________ ___

Appendix C – Letter of Information and Consent

INFORMATION LETTER

Occupational and Biomechanics Lab, Department of Kinesiology
University of Waterloo

Study Title:	***Evaluating the Prospective Benefits of Physical Demands Description (PDD) Data Created from Job Simulations***
Student Investigator:	***Nicholas Patrick R. Kin, Department of Kinesiology,*** *npatrick@uwaterloo.ca*
Faculty Supervisory	***Steven L. Fischer, PhD, RKin, CCPE, Assistant Professor, Department of Kinesiology,*** *steven.fischer@uwaterloo.ca*, ***519-888-4567x30368***

Introduction
Physical demands descriptions (PDDs) play a critical role within the return to work process. Recent research has uncovered issues with regards to the development, and utilization of PDDs. As a means of addressing concerns regarding the development of a PDD, digital human modeling (DHM) software has been proposed as a method to create simulations of jobs, which in turn can be used to generate a PDD. DHM software allows the end user to easily input workplace measurements and to calculate a wide variety of relevant ergonomic data, where some of these additional data may be beneficial to the end users of PDDs.

Purpose of the Study
The purpose of this study is to examine kinesiologists, ergonomists and disability/return to work case manager opinions on the traditional PDD process, the use of PDDs within current practice and the prospective benefits and limitations of PDDs created from a digital human model-based job simulation. Opinions will be used to guide the further research into the use and development of PDDs, as well as further development of PDDs created from job simulations.

Inclusion Criteria:
Kinesiologists and Ergonomists, and Case Managers whose professional practice involves PDD generation and/or PDD use within the return-to-work process.

Exclusion Criteria:
Individuals who do not consent to having audio of their discussions recorded

Procedures Involved in this Study and Time Commitment

Upon arrival, you will be given a demographic questionnaire to complete, inviting you to provide information including your age, gender, years of professional practice. If you are not comfortable providing any details on this form, please inform the student investigator prior to consenting to participation. During the focus group sessions audio recordings will be taken in order to capture the conversation for later transcription. Video recording will accompany the audio recording in order to ensure accuracy of the script transcribed from the audio recordings.

The entire protocol will last approximately 90 minutes.

Instrumentation

Focus group session will be recorded, utilizing both audio and video recorders

Experimental Protocol

The protocol will begin with the participants completing a demographic survey. Once all participants have completed the survey, the focus group discussion session will commence. Sessions will consist of approximately 8 participants along with 2 investigators (a moderator and a note taker). Focus groups will be moderated using a semi-structured approach; the investigators will aim to ensure the discussion will remain reasonably focused on topics related to PDDs, the return to work process, and ergonomic assessments. At points throughout the discussions the investigators will present the participants with examples of PDDs and accompanying reference material for examination.

Potential Risks and Associated Safeguards

None.

Changing Your Mind about Participation

You may withdraw from the study at any time without penalty or loss of remuneration. To do so, indicate this to the investigators by saying, “I no longer wish to participate in this study”.

Potential Benefits of Participation

You will have the opportunity to further your knowledge and understanding of the return-to-work process utilized by organizations other than your own. You also have the opportunity to further your knowledge regarding the utilization of digital human modeling processes and capabilities with respect to their application in a return-to-work context. Additionally, your participation in this research will help identify any current gaps in knowledge regarding the use of PDDs within the return to work process

Remuneration

You will receive remuneration for participating in this study. You will receive $50. The amount received is taxable. It is your responsibility to report this amount for income tax purposes.

Confidentiality and Security of Data

This information letter and consent form will be the only document to use your name. An alphanumeric or numerical code will be associated with your name; no personal identifiers will be included. The alphanumeric/numerical code will be used with the video recording. All data will be stored on a password-protected network drive, associated with the Occupational Biomechanics and Ergonomics Lab, and lab computers, which are also password protected. All photos/videos will also be stored on this drive. The videos will be transferred immediately after collection, and then deleted from the camera. All written, electronic and imaging data will be stored for a minimum of 7 years. With your permission photos/video clips from your participation may be used in publications, teaching or research presentations. In these, your face and other identifying details will be cropped, blurred or removed and your name will not be used.

Concerns about Participation

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#22792). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or **ore-ceo@uwaterloo.ca**. For all other questions, contact Nicholas Patrick at **npatrick@uwaterloo.ca** or Dr. Steven Fischer at **sfischer@uwaterloo.ca**, or at 519-888-4567, ext. 30368.

Questions about the Study

For all other questions or if you want any other information about this study, please feel free to contact Nicholas Patrick or Dr. Steven Fischer (contact information provided below).

Sincerely Yours,

Nicholas Patrick R. Kin	Steven L. Fischer, PhD, R. Kin, CCPE
BMH 1115	BMH 1046
npatrick@uwaterloo.ca	sfischer@uwaterloo.ca

CONSENT OF PARTICIPANT, VIDEOTAPING, AND AUDIO RECORDING

By signing this consent form, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study being conducted by Nicholas Patrick and Dr. Steven Fischer of the Department of Kinesiology at the University of Waterloo. I have had the opportunity to ask any questions related to this study, to receive satisfactory answers to my questions, and any additional details I wanted. I am aware that I may withdraw from the study without penalty at any time by advising the researchers of this decision.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#22792). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca. For all other questions contact Nicholas Patrick at npatrick@uwaterloo.ca or Dr. Steven Fischer at sfischer@uwaterloo.ca, or at 519-888-4567, ext. 30368.

Please circle 'yes' for each statement you agree to:

With full knowledge of all foregoing, I agree, of my own free will, to participate in this study.

Yes / No

As a participant in this study, I agree to have my audio of my conversations recorded for the purpose of analyzing my thoughts, and opinions of the presented physical demands descriptions, and associated discussions. I am aware that I may withdraw this consent at any time without penalty, at which point, this audio recording will be erased.

Yes / No

As a participant in this study, I agree to being videotaped for the purpose of assisting the audio transcription process as well as a means of verifying results from other data collected, ex. Hand written notes. I am aware that I may withdraw this consent at any time without penalty, at which point, the videotape will be erased.

Yes / No

I agree to allow the transcribed audio data to be used in teaching, scientific presentations and/or publications with the understanding that any identifying characteristics will be removed. I am aware that I may withdraw this consent at any time before materials have been published without penalty. I understand that it is not possible to withdraw my consent once papers and publications have been submitted to publishers.

Yes / No

Participant's Name (Please Print): ____

Participant's Signature: ____

Dated at Waterloo, ON:____

Witnessed____

Appendix D- Recruitment Email

My name is Nicholas Patrick and I am a MSc student working in the the Occupational Biomechanics and Ergonomics Lab (https://uwaterloo.ca/obel) located within the Kinesiology Department at the University of Waterloo. My supervisor, Dr. Steven Fischer and I are conducting research regarding the use physical demands descriptions (PDDs) within the return to work process. We are also looking to investigate the use of a new method in PDD development utilizing a simulation created using digital human modeling software. We are looking to gather information using focus groups to help us better understand how you might use PDDs in the return-to-work context, what information in a PDD you find useful/not helpful, and if you see value in our novel ePDD (electronic PDD developed from a job simulation).

Participation in this study requires that you join us at the University of Waterloo. The focus group session will run approximately 90 minutes in length and consist of approximately 6-8 individuals. I will moderate our conversation to keep it directed on the topic of PDDs, the return to work process and the novel ePDD approach. You will be provided with samples of PDD and ePDDs generated from the same jobs in order to provide context for the discussion.

I am inviting Registered Kinesiologists (R.Kin), Canadian Certified Professional Ergonomists (CCPE), Canadian Associate Ergonomists (AE), and return to work Case Managers whose role involves return-to-work treatment/planning or those who may work directly on the development of PDDs to participate in this study.

In appreciation of your time, you will receive a **$50 gift card**. I would like to assure you that the study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee. However, the final decision about participation is yours.

If you are interested in participating or have any questions please contact me at npatrick@uwaterloo.ca. I will work with you to arrange a time for you to participate and I can also follow up on any questions that you may have. Thank you for considering our invitation!

Sincerely,

Nicholas Patrick, BSc. R.Kin
MSc Candidate, Occupational Biomechanics and Ergonomics Lab
Department of Kinesiology, University of Waterloo

Appendix E – Feedback Letter

FEEDBACK LETTER

Occupational and Biomechanics Lab, Department of Kinesiology

University of Waterloo

Project Title: ***Evaluating the Prospective Benefits of Physical Demands Description (PDD) Data Created from***

Job Simulations

Student Investigator: ***Nicholas Patrick R. Kin , Department of Kinesiology,***

npatrick@uwaterloo.ca

Faculty Advisor: ***Steven L. Fischer, PhD, R. Kin, CCPE, Assistant Professor, Department of Kinesiology,*** steven.fischer@uwaterloo.ca***,***

519 888 4567 x 30368

We appreciate your participation in our study, and thank you for spending the time helping us with our research!

In this study you participated in focus groups examining your opinions regarding the use of physical demands descriptions (PDDs) within a return to work context. There are three main goals to this study; to gain an understanding as to how PDDs are used within the return to work process; uncover any issues that may exist with regards to the current application of PDD information; and obtain feedback for the proposed digital human model simulation approach to the generation of a PDD as method to provide the end user with a more complete set of data within a PDD, drawbacks and areas of improvement of the PDDs generated from simulations compared to traditionally developed PDDs from the same job.

Audio data collected will be transcribed, and video collected will be used to assist in the transcription process. The transcribed discussions will be thematically analyzed in order to uncover end user thoughts, opinions and criticisms regarding the topics discussed during the session.

It is expected that many areas of interest (improvement) with regards to the current use of PDDs will be uncovered during this investigation, as well as the PDDs developed from simulations. These identified areas of interest are of importance because they will be used to inform future directions regarding the education of students in disciplines related to the return to work space. Areas of interest regarding shortcomings of the use of current PDDs will inform changes to the digitally simulated PDDs in order to maximize the clinical utility of the tool. Previous research regarding the development of PDDs has shown that there are certain issues that arise during the development of the document which may hinder its overall effectiveness, the use of a digital simulation has been proposed as a means of overcoming these concerns. With the ability of digital simulations to provide the end user with data previously unavailable to the end user, we do not understand which information may provide the most impact. This study aims to evaluate digital human model developed PDDs in terms of the benefits to the end user. This research will help guide the improvement and development of digital human model developed PDDs.

All information you provided is considered completely confidential; your name will not be included or in any other way associated with the data collected in the study. With your given permission excerpts from the discussion may be used in publications, teaching or research presentations. In these, any potentially identifying information will be removed/modified in order to protect your identity. Paper records of data collected during this study will be retained for a minimum of seven years in a locked filing cabinet in in LHS 1610. Only the researchers associated with this study have access to LHS 1610 or to the locked filing cabinet. Electronic data and audio recordings will be kept indefinitely on a secure University of Waterloo owned and operated server, to which only researchers associated with this study have access. All identifying information will be removed from the records prior to storage.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Committee (ORE#22792). If you have questions for the Committee contact the Chief Ethics Officer, Office of Research Ethics, at 1-519-888-4567 ext. 36005 or ore-ceo@uwaterloo.ca.

For all other questions contact Nicholas Patrick at npatrick@uwaterloo.ca or Dr. Steven Fischer at sfischer@uwaterloo.ca, or at 519-888-4567, ext. 30368.

If you think of some other questions regarding this study, please do not hesitate to contact a member of the research team.

We really appreciate your participation, and hope that this has been an interesting experience for you.

Appendix F – Data Analysis Code Book

Text Passage	Code	Description	Sub-theme	Major Theme
I think if you're going to try and accommodate someone at work you need more details that just a summary of that stuff	Job Matching requires detailed PDD data	Information in the PDD document is used to form basis of RTW decisions, i.e. job match suitability	What information required for job match	PDD Use in Job Match
like if I'm a physician I'm not going to read 5 pages of my JDA so they want to see ok sedentary ok that's the scope of work ok summary of physical demands but these checklists that people give you sometimes	What does the reader need in a PDD	PDD date varies greatly, what information is required in order to make RTW decisions	What information required for job match	PDD Use in Job Match
we need a quick and dirty PDA I have reached out for them to gather that information again its usually time sensitive because we are trying to coordinate a RTW and have our insurance company or a Dr who we need to get the information	PDD is reactive process to inform job match usually	PDDs are not always available so employers sometimes struggle with having the information required to make a job match available, how is this data created	What information required for job match	PDD Use in Job Match
getting the restrictions from a specialist or physician will there be through a medical certificate of disability or a FAF WSIB has their own restrictions that would be a bit different essentially taking those restrictions and comparing to the demands of the job then of	PDD use for base of job match	PDDs are used as the basis of the job match from the job demands side	What information required for job match	PDD Use in Job Match

course collaborate wit the manager of the employee and myself and union if necessary				
in terms of not making the decisions of like can this person be in this job any more like a really serious thing where the person is depending on this for their livelihood I obviously wouldn't want to use one that's from a general pool of PDDs I would want a specific one for the jobs that this person actually did not that they are person specific but I would want it to reflect the job much more	PDD specificity requirements need to match job accurately	PDDs may be specific to the worker or may be generic, however generic documents rarely provide the required information to handle challenging RTW cases	What information required for job match	PDD Use in Job Match
I think for the most part the roles of PDD for insurance carrier I think identifying those assumptions in the PDD will suffice unless it's quite contentious then you would escalated beyond the information within the PDD that's for the case management to come in and they may want to look into a specific might be Preventing someone from returning to work	What point is PDD insufficient in process	PDDs are one component of the job match process, but often times are not the limiting factor preventing a worker from returning to work	What information required for job match	PDD Use in Job Match
well you know like a lot of like a production manager or someone will be like oh well they do this 10 times every minute but we would be like what does that mean in terms of like	Difficulty in obtaining accurate information	PDD data collections may not be simple, and often times required assistance from other workplace parties, if other	PDD Data Quality	PDD Job Match Barriers

repetitive body parts are they gripping 10 times a minute or are they grip 5 times to do that one task every minute right it's kind of Translating that information into something that can be used for you know if they have no repetitive back-bending to be able to match those two together	during PDD collection	parties are unaware of the necessity of accurate data they may not provide data at a level of accuracy that is acceptable in a PDD		
if there is some sort of standardized way that people write these we have our way of writing PDA but obviously a lot of other people have different ways of writing PDAs and most a lot of people use the wsib ffaf form but some companies have their own that form which either has more or less detail then that so I mean I know every person is different every workplace is different	Inconsistent PDD format	PDDs are not standardized, and variations exist in practice, however these variations in structure also impact the quality and quantity of information provided	PDD data quality	PDD job match barriers
some of them have being wrong now that may be because the job the PDA is outdated right that could have like things on the job could have changed	PDD can be outdated	PDDs may not be the most accurate or up to date as employers tend to develop document reactively vs proactively	PDD data quality	PDD Job Match Barriers
I couldn’t understand what they were saying in the document like they are very unreadable that one I had I could probably get a copy of it and just take off the	How does the PDD document read in practice	PDDs may not the be most easy to read documents in practice, how does that affect their use in RTW if the data is	PDD data quality	PDD Job Match Barriers

name but it made absolutely no sense		unable to be obtained from the document		
there's another company where they have someone weigh everything and they handed me a list of weights of books and forks and plates and this is how much 1 kettle weighs and so on again we have to standardize the information an make sure the information is clear and easy to understand and standardized	PDD information can be overwhelming	PDDs may be complex technical documents that are not the most user friendly, or provide information as to how the information was gathered, if random measurements are taken it is challenging to compile all information and compare against FAF/abilities	PDD data quality	PDD Job Match Barriers
they are walking for 33-66% of their day but what does that actually mean there would be no kind of broader explanation	Vague PDD data does not assist RTW	Data in PDD needs to be usable to reader, if data is too vague it cannot be applied to case	PDD data quality	PDD job match barriers
Yes and I think that it maybe useful to look into what Dr most commonly prescribe and that would it should be focused on it's the things that I look at every day maybe that is because I work at parts place a warehouse and maybe if I was doing ergo assessments on lifeguards it would be different	How do PDD and FAF align	When reviewing documents it is important to review how the documents you develop can be used in practice and if changes could be made to increase alignment		How PDD information relates to FAF
I'm from the demand like physical demands side just you know a PDA that's going to match what the	Align PDD w FAF for easy use	If PDD documents and restriction documentation (FAF) were written in		How PDD information relates to FAF

health care provider is giving you because if there is some sort of standardized way that people write these we have our way of writing PDA but obviously a lot of other people have different ways of writing PDAs and most a lot of people use the wsib ffaf form but some companies have their own that form which either has more or less detail then that so I mean I know every person is different every workplace is different and you have to always have a person		same language it would make comparison much quicker easier and would reduce errors in process		
and I think there needs to be more between the functional capacity assessment and the job demands analysis there kinda needs to be some continuity there cuz I feel like sometimes for trying to compare apples and oranges	PDD job match process needs to be more aligned with FAF	PDD and FAF are two documents that may be used to compare demands and capacities, if the information in the documents does not align it becomes a challenge to compare the two		How PDD information relates to FAF
a restriction that may come in that is pretty common might have something to do with lifting or reaching above shoulder height though they're two they're pretty common and so every time I said they should ask for help they should ask for help they shouldn't be more than 20 lb they should ask a colleague for help you need to be mindful of you in terms of practicality	Detailed PDD data allows for modification decision to be made that can impact entire workforce	Job modification efforts may not only impact the injured worker, and must be taken into account for the overall wellbeing of the organization, a good PDD assists in the decision making process	PDD informs job modification efforts	PDD use in Job Modification

because what you find is that people it is important to know if they work alone or work as a team if it practical to always ask somebody for help				
so if you are going off a summary or a worst case scenario I don't think you have the whole picture I think they are helpful as a starting point and saying okay maybe we can rework this job lets go take a look at it or you know this job may work for him let me talk to the supervisor and see if we can change things so he doesn't have to get out of his vehicle I know it says here that you are suppose to get out and move the pallets or something but maybe we can get it so he doesn't have to do that so I think if you're just using them as sort of law it gets sort of tricky	PDD can be used to inform initial directions for job modification	Job modification is not a single action, it is a process that is collaborative and involves many workplace parties	PDD informs job modification efforts	PDD use in Job Modification
I just find in general I that's more my beef with Hr people that they don't necessarily refer to the job description of the PDA until something gets usually it comes up when something in contentious	PDD may not be part of RTW process	PDDs are a tool that may or may not be used in RTW, depending on the individuals leading the process or the organization they represent	PDD not used enough in RTW	PDD not used in RTW

I would say they are not used enough in the sense that they are not referred to as much as they should be	PDD not used enough in RTW process	PDD may be available however may not be used in RTW depending on who is directing the RTW process and how that process is structured	PDD not used enough in RTW	PDD not used in RTW
so we don't always use a PDD for example if it's fairly obvious you know what the restrictions	PDD not required if simple restrictions	PDD are a tool that may or may not be necessary	PDD not required if restrictions simple	PDD not used in RTW
if you were to get more details with it the situation that I think would be more helpful would be somebody trying to prove so if somebody loses time because of a workplace injury right but the physician says they can come back to modified duties but they they can't repetitively bend the left elbow we offer them work as an office job or something right if they say no and then go off work its sort of the employers duty to prove that the work we offered this suitable so in that situation it would be helpful to have a PDD	Where does PD data come into play in RTW	The RTW process is not standardized and the inclusion of information is up to the professionals handling the case, when and where to bring in more information are at the professionals discretion	PDD not required if restrictions simple	PDD not used in RTW
Yeah so the only time I mean I guess I do sort of a mini PDD every time I'm canvasing so if you have someone coming off like on medical leave or if we have somebody with permanent restriction and we have a list I canvas	Full PDD may not be required	Depending on the employer and the structure of the organization it may not be required to perform a full PDD for all jobs and all cases if there are enough resources10	Used for quick look not detailed review	PDD not used in RTW

		avail able to handle the RTW case		
think it depends like if I get a PDA I will usually review it not in depth but have a quick glance through	PDD not used much in RTW	Professional discretion applies to how and when information may be used in RTW	Used for quick look not detailed review	PDD not used in RTW
I needed sometimes also because I didn't want to just observe one person I want to know multiple people I want to talk to the management and other people about the task	Subjective vs objective information	PDD data should be a description of the job being performed not just one workers process but what needs to be done to complete the job	Subjective vs objective information	Match PDD with restriction information
want to know the demands and of the job yea probably weights forces and frequencies but really a lot of the information we get comes from the worker like how you feeling what do you think you can do what do you think you can't do	How does subjective data play a role in the job match	The workers subjective information plays a significant role in RTW, how is that information utilized in RTW and how does that align with the objective job information	Subjective vs objective information	Match PDD with restriction information
the most important thing like if you're going to go that far to do something you need to make sure that It's usable I mean if it's not usable then there's no point I shouldn't say that there's probably A point because that's like a first step You have the vehicle to support that but now how do you put in the data to support it	Valid usable tool for use in RTW	How does one develop valid tools that are usable to all parties in RTW and functional given the other information in the RTW process, i.e. FAFs	PDD usability for all parties	Match PDD with restriction information

how I created my PDA when I started I actually job shadowed this ergonomist and he was like the gold standard his was kind of Overkill with 30 pages he had a methodology and would write rogers muscle fatigue and in brief in 3 or 4 sentences would explain what rogers muscle fatigue is and how your applying it within the context of the JDA	PDD formatting no set standard for PDD document	PDD documents vary as greatly as the number of individuals developing them, this leads to questions and concerns with usability as there is very little required to call a document a PDD	How does developer skill impact document	Lack of standardization in PDD development
No we will reach out to the physios in the community and you know the professionals where their restrictions come from and sometimes private contracts we will send out contracted OTs to do these PDAs if I cant make it out myself so the union would send out their own contracted OT to run the PDA and I will touch base to work with them.	Different PDD practitioners develop document, how do these documents differ	PDDs may be completed by anyone, how does this affect overall quality	Who creates PDDs	Lack of standardization in PDD development
I hate when I get a JDA and it's just a bunch of check marks like this isn't a grocery list this is someone's job so you don't want to have too much narrative but it should be informative enough	PDD formatting no standard of what PDD is	PDD differ greatly and can be very detailed or minimally detailed , checklist vs long form document	Checklist vs longform documents	PDD formatting

it's kind of more useful to do a big detail one especially for those really repetitive jobs that people are always getting restrictions	Detail vs short documents	What information does the RTW professional prefer in their practice	Checklist vs long documents	PDD formatting
I think you are going to get a lot of answers and everyone is going to tell you why what they like is best but I think it’s a matter of personal preference you want to be as clear as possible it should be ideally fairly intuitive and someone who does not know about the job should be able to pick it up and read it and understand it does that happen no does it require a bit of experience to understand them yea but I think a lot of it is personal preference	PDD no one best structure	PDD preference is highly personal and no one structure, either summary or task by task will universally by preferred	PDD formatting task vs summary	Task format vs summary
and then you can have them done professionally and poorly professionally from the people that I have seen done so far that I don’t care for the readability and understanding I’ve reviewed ones that are 12 pages long who has time especially in my world where I used to work	What information is in the PDD document	PDD information varies, how does that affect RTW decision		PDD needs to be easy to read
I think rarely just you looking at documents like that even when I have restrictions so even when I have restrictions on file I end up going to explain it to people but then sometimes they just want to read it and see it themselves so usually so you might end up showing it to a union person a supervisor you	PDD needs to be easy to read	Readability is key for all skill levels in RTW process		PDD needs to be easy to read

might end up showing to the employee you should be able to do it because here it says your own lifting 8.3kg right so				
I mean you could but if it is hard to print and honestly if you can summarize a job in a one-page like one printed sheet I think people start getting confused and lost when they start having multiple pages and they have to read it all	One page summary useful	Information needs to be useful to parties in RTW, too much information many be challenging to read for all reader	Task vs summary format	PDD formatting
clear legible easy to understand summary of exposure to a given physical demand when I can just glance at it I can see this this and this well that is your injury its not an issue then because your primary physical demands of the job are not effected that is helpful to me	Clear summary is good for quick review	Quick use of document in critical in RTW as many cases not a lot of time is provided for review	Task vs summary format	PDD formatting
if they knew there was specific they were lifting and carrying up to 50lbs every day or whatever push and pull I would notice and I notice it hear too that in know for a fact they are pushing and pulling carts so that is something that is no in the PDA I suspect that it's because whoever made the PDA didn't have the equipment to measure push pull force	PDD how to capture relevant information	PDD data collections are not standardized, thus it is important to know how the information was collected	How is data collected	Lack of standardization in PDD development
I used to I mean the jobs are at my place can be	How to describe non	PDD capturing non standard work are	Who created the PDD and	Lack of standardization

done lots of different ways and its not as repetitive as other places so they might get an order for 20 parts and one of those parts can weigh 15lbs one can weight 100mg like I could be a nut or bolt they are going that all day so it gets difficult to use d PDD because you have to say best cased scenario or worst case they are lifting a thousand parts at 25lbs best case is 1000 at a couple ounces	standard work condition	difficult to develop, how does the skill and experience of the assessor impact the quality of the document	how does their skill impact the document	in PDD development
then we can escalate that in that regard one of the big challenges is going to be instrumentation that we may have you know moving patient is going to be very difficult to assess	No set criteria on how to measure demands	AS there is no set standards in place with regards to how the measure job demands, how the demands are measure becomes important for validation and verification of the information in the PDD	How is data collected	Lack of Standardization I PDD development
they missed and there wasn't even a description section and for me some sort of description of what lifting pushing pulling carrying the individual is doing is the most important part because it tells you what that's the description in some way shape or form that is really the meat of what you need	PDD missing information	Information may be missing from a PDD	Missing or incorrect information	Obviously poor PDD data
but we don't necessarily have the greatest library of either simple job descriptions or PDAs so when we are actually trying to look at an employee saying I do this I do these	PDD may not reflect how job is performed	PDDs are documents, work is dynamic, it is possible that PDD does not reflect how the work is being	Ideal work vs work being completed	Work practice differences

specific duties we don't necessarily have that documented somewhere or so we will have to get the local HR local management to validate you know in some cases a job has morphed a bit		performed in practice		
that is where it gets contentious too right because the employee says that here for example when they are loading or unloading they have a conveyor belt they need to manually have to I want to say collapsible so you can push them in and then you can extend them out but they have to move them manually the employees will say that I can't do that but that specific activity is not documented anywhere so I cannot say it requires this much force so even if we wanted to go through some kind of functional evaluation	PDD may no encompass entire job	PDDs are documents, work is dynamic, it is possible that PDD does not reflect how the work is being performed in practice, some information may be missed	Ideal work vs work being completed	Work practice differences
I think another one is just related to physical demands is the usually tied to lifting or strength demands is access to some kind of assistive device	How to quantify work demands for all tools	Some demands on the body are difficult to measure, such as the use of tools or assistive devices, these may not impart consistent loads upon the worker, or be used consistently how to quantify those in practice	Some tasks not easily quantified	Work Practice difference
metabolic tab my first thought is that it's interesting I think the H&s people would be more interested in a labour job and that information would be more useful for them but	Some data in ePDD document useful outside of RTW	Information in the ePDD may not be useful in RTW but can be helpful in other areas of the organization	Detailed ergo analysis	Value outside of RTW

I still think it is cool to have it				
n their centromeres want to go in and say okay let's see we're going to move this over here then they could use that data from Jack changing themselves and then you know if something came out that popped up you don't know that location is going to be red for the shoulder or whatever then that would be super valuable I think as you said for the the industrial Engineers as well I think it would be you know if they drop out that 3 seconds of rest time and everything turns red then you know kind of let's find a balance here lets find something else to do I think it's more in their language to right	ePDD more ergo assessment than RTW tool	ePDD information may be more useful in ergonomic analysis than RTW	Detailed ergo analysis	Value outside of RTW
maybe in a physio I don’t know who would be looking at the amount of flexion extension if they need to know that specific but for me it was a little hard to read	ePDD too technical and hard to read	The ePDD may be difficult for some reader to gather information from	Confusing lots of information	Difficult to read
Maybe a definition of what all the terms mean would be good ill see like reach metrics its measured in cm so that’s good maybe a description in like one column like get right angle what does that mean get socket obviously its getting the socket off the wheel maybe like a slight	Task breakdown not as clear	Some information in the ePDD is not clear to the reader and is a challenge to pull	Summary information lacking	Difficult to read

description of the task oh there				
It's a small thing but I have learned that people are lazy so if it would be possible to move the raw data to the end so that it opens on the posture and task demands because I can just picture people saying what am I looking at and they won't automatically click on other tabs that would be the one thing that I would change I don't think there's anything that would detract from its usefulness as it is right now	Change document to guide reader	ePDD document is a change from what most are accustom, and may benefit from instructions in order to guide the reader	Confusing lots of information	Difficult to read
I don't quite understand how the excel files work are they a separate file or are they linked that has the current information I guess for the video is that right	ePDD different from other PDDs and unclear how to use		Different from other PDDs	Difficult to read
I think if im being totally straight with you disability management is probably more information than you need because you are just focused on the injury	Overkill for typical RTW case	The ePDD provides information that is typically not necessary for RTW	To much detail for the average RTW	More information than average PDD
I think it's a pretty cool idea I think that it's a pretty good way to get a lot of objective information I would imagine that it was pretty labour intensive to do an if the process could be less labour intensive and streamlined because ultimately that is your barometer if its easier to have a human come in and do the PDD then that's	Good start but difficult to orient self with ePDD	The ePDD shows promise but in the current format is challenging to use in RTW	Difficult to understand what is going on	Information Content

where the effectiveness of the method comes in and at that points it's a matter of how you present the data and you need to be a little more clear on whats the task whats the data I think you have a great idea				
when I look at this the paper part I can't at all tell what's going on or what the task is so I think the two of them together works very well	ePDD document lacks readability and the	The ePDD document as a stand alone lacks readability and the narrative content to orient the reader is a challenge to use	Difficult to understand what is going on	Information content
I know that generally our more senior HR people or more seasoned who have been here longer I don't get those questions because they have a better understanding because they have learned overtime so I think another aspect to this is that it would be a good learning tool that pretty easy to follow for someone who doesn't have a kin background I think I don't have any other big asks for it I think that in conjunction with having a video to me it's a really good option vast improvement on the traditional way	ePDD video is good at conveying information	Video is a useful addition to a PDD to convey information to the reader	Video of job rely on for context	Good use of visuals
reach and hand time travel distance travel distance I did wonder what particularly that was going to tell me about thing how active they were if they went a whole bunch of 10cm moves like I think the reach part the graph on the right that shows hand travel	Data presentation quickly transfers information	Visual presentation of information in the ePDD allow for quick information transfer	Quick information transfer	Use of visuals to present information

how many times they did one time at 70 75 or whatever centimeters 2 times at 35 25 cm it's a weird kind of graph the most but it's around just over 10 was just under 60 so you would want to look at say if they did that 7 times in a that one cycle if we could reduce that but the ones at 40 are important to so that's				
is handy to have it is a good reference its no replacement for seeing the job but there is no harm in having them ever and I see value in them	visuals good but no replacement for live job observation		Video of job not better than observation	Good use of visuals
Like this is not clean it doesn't look finished I think that its aesthetic I think with a little more nomenclature it could be more intuitive	ePDD needs more description to explain	The ePDD relies on the use of video to provide context to the information currently, with more description in the document that might not be the case	Rely on video for context of job	Good use of visuals
No I think its really clear its good nothing needs to be changed on this tab it all makes sense to me	ePDD use of visuals for information transfer		Use of charts an graphs for quick information transfer	Good use of visuals to present information

Appendix G –Sample PDD and ePDD Provided to Participants

Sample ePDD

[illegible]

--------Analysis Details--------

Figure:	human
Weight:	69.100 kg
Height:	167.32 cm
Gender:	Female
Cycle Time (sec):	45

--------Task Details----------

Task	Action	Frequency	Duration (s)	MEE Task Category	Net Metabolic Cost (kcal)
Reach_to__open_door	Pose	1	1	None	0
Open_Door	Apply_Force	1	1.5	arm work - general - heavy - one arm	0.058
Get_harness_from_floor	Walk	1	0.685	walking	0.019
Get_harness_from_floor	Bend_And_Reach + Grasp	1	1.991	lowering - stoop	0.028
Move_to_rip_harness_tape	Pose	1	1	None	0
grasp_harness_in_both_hands	Regrasp	1	0.203	hand work - general - light	0.001
tear_tape_from_harness	Apply_Force	1	2	arm work - general - light - both arm	0.04
release_harness_from_left_hand_for_insertion_int	Regrasp	1	0.203	hand work - general - light	0.001
Route_harness_into_door_through_large_opening	Reach	1	0.882	arm work - horizontal - standing	0.018
Place_harness_through_grommet_hole	Reach + Release	1	0.144	arm work - general - light - one arm	0.002
Walk	Walk	1	0.9	N/A - walk with no load	0
Grasp_harness_through_grommet_hole	Reach + Grasp	1	1.078	arm work - general - light - one arm	0.013
Pull_harness_to_seat_grommet	Apply_Force + Release	1	2.073	arm work - general - heavy - one arm	0.082
Reach_to_seat_internal_harness_clip_nearest_to_	Pose	1	1	None	0
Seat_clip_nearest_to_grommet	Apply_Force	1	1.1	arm work - general - light - one arm	0.013
Grasp_harness_clip_lower_	Pose	1	1	None	0
Seat_harness_clip_lower	Apply_Force	1	1.101	arm work - general - light - one arm	0.013
Grasp_harness_clip_B_pillar_shut_face	Pose	1	2	None	0
Seat_clip_b_pillar_shut_face	Apply_Force	1	1.1	arm work - general - light - one arm	0.013
Grasp_clip_below_speaker_opening_near_b_pillar	Pose	1	1	None	0
Seat_harness_clip_below_speaker_cutout_front	Apply_Force	1	1.1	arm work - general - light - one arm	0.013
Grasp_harness_clip_below_speaker_cutout_rear	Pose	1	1	None	0
Seat_clip_below_speaker_cutout_rear	Apply_Force	1	1.1	arm work - general - light - one arm	0.013
Grasp_Outer_harness_pin	Pose	1	1	None	0
Apply_Force_RH_Rear_Door_w_Wiring	Apply_Force	1	1	arm work - general - light - one arm	0.012
Go	Arise_From_Bend	1	1.148	lowering - stoop + arm	0.048
Go	Walk	1	2.098	walking	0.058
Get_RH_Rear_Door_w_Wiring	Walk	1	0.454	walking	0.013
Get_RH_Rear_Door_w_Wiring	Reach + Grasp	1	1.208	arm work - general - light - both arm	0.024
Apply_Force_RH_Rear_Door_w_Wiring_0	Apply_Force + Release	1	1.073	arm work - general - heavy - both arr	0.088

Task Component Total (kcal): 0.461

--Postural Maintenance Details--

Standing (kcal):	1.306
Sitting (kcal):	0
Bent (kcal):	0.062
Postural Component Total (kcal):	1.368

Total Metabolic Cost (kcal): 1.828 (Calculated as the sum of Task and Postural Maintenance metabolic costs)

- Cumulative Low Back Loading -

Total Cumulative Compression/Shift (MNs): 20.27 (Includes loading incurred during active work and idle time)

The low back cumulative compression exposure for this shift DOES NOT EXCEED the threshold of 22.50 MNs.

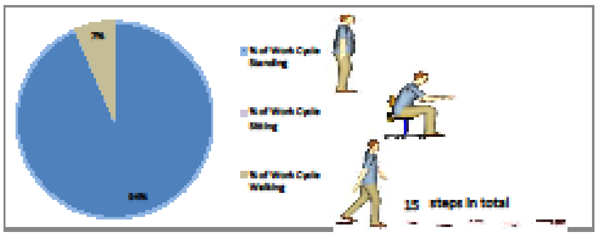
Total Cumulative Moment/Shift (MNms): 0.47 (Includes moment incurred during active work and idle time)

The low back cumulative moment exposure for this shift DOES NOT EXCEED the threshold of 0.80 MNms.

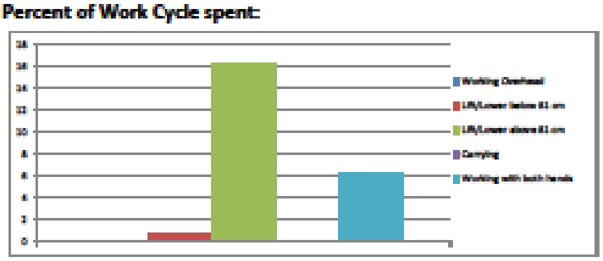
Task	Action	Action Duration (s)	Rep/Shift	Compression (N)	Action CL (Ns)	Action CL/Shift	Abs Flex/Ext Mom	Action CM (Nms)	Action CM/Shift
Reach_to__open_door	Pose	1	600	432.47	432.47	259482	8.38	8.38	5028
Open_Door	Apply_Force	1.5	600	1294.91	1942.37	1165419	40.06	60.09	36054
Get_harness_from_floor	Walk	0.69	600	312.29	215.48	129288.06	1.59	1.07	635.86
	Get	1.99	600	1240.7	2478.94	1487365.8	60.9	121.19	72714.6
Move_to_rip_harness_tape	Pose	1	600	1347.96	1347.96	808776	64.88	64.88	38928
grasp_harness_in_both_hands	Regrasp	0.2	600	476.4	95.28	57168	8.63	1.73	1035.6
tear_tape_from_harness	Apply_Force	2	600	555.08	1110.16	666096	8.64	17.28	10368
release_harness_from_left_hand_for_insertion_int	Regrasp	0.2	600	400.53	80.06	48036.4	5	1	600
Route_harness_into_door_through_large_opening	Position	0.83	600	516.63	430.46	258277.74	12.28	10.19	6115.44
Place_harness_through_grommet_hole	Put	0.14	600	518.54	72.74	43641.36	12.34	1.73	1036.56
Walk	Walk	0.9	600	449.81	222.81	133686	7.88	3.94	2364
Grasp_harness_through_grommet_hole	Get	1.08	600	502.01	542.17	325302.48	11.9	12.85	7711.2
Pull_harness_to_seat_grommet	Apply_Force	2.07	600	1784.68	3694.7	2216820.96	60.66	125.57	75339.72
Reach_to_seat_internal_harness_clip_nearest_to_	Pose	1	600	687.53	687.53	412518	23.68	23.68	14208
Seat_clip_nearest_to_grommet	Apply_Force	1.1	600	495.37	544.91	326944.2	11.41	12.55	7530.6
Grasp_harness_clip_lower_	Pose	1	600	438.27	438.27	262962	6.86	6.86	4116
Seat_harness_clip_lower	Apply_Force	1.1	600	478.77	526.65	315988.2	10.41	11.45	6870.6
Grasp_harness_clip_B_pillar_shut_face	Pose	2	600	580.08	1160.16	696096	14.67	29.34	17604
Seat_clip_b_pillar_shut_face	Apply_Force	1.1	600	677.42	745.16	447097.2	21.46	23.61	14165.6
Grasp_clip_below_speaker_opening_near_b_pillar	Pose	1	600	618.08	618.08	370848	15.37	15.37	9222
Seat_harness_clip_below_speaker_cutout_front	Apply_Force	1.1	600	752.41	828.65	496590.6	27.07	29.78	17866.2
Grasp_harness_clip_below_speaker_cutout_rear	Pose	1	600	628.77	628.77	377262	15.43	15.43	9258
Seat_clip_below_speaker_cutout_rear	Apply_Force	1.1	600	614.22	675.64	405385.2	15.15	16.66	10000.8
Grasp_Outer_harness_pin	Pose	1	600	622.39	622.39	373434	15.45	15.45	9270
Apply_Force_RH_Rear_Door_w_Wiring	Apply_Force	1	600	595.11	595.11	357066	11.29	11.29	6774
Go	Posture Change	1.15	600	632.82	727.74	436643.6	13.11	15.08	9048.6
	Walk	2.1	600	350.84	736.76	442056.4	2.12	4.45	2671.2
Get_RH_Rear_Door_w_Wiring	Walk	0.45	600	330.41	148.68	89210.7	0.87	0.39	234.9
	Get	1.21	600	526.4	636.94	382166.4	9.58	11.59	6955.68
Apply_Force_RH_Rear_Door_w_Wiring_0	Apply_Force	1.07	600	481.83	515.56	309335.7	4.58	4.9	2940.36

JobTitle:	RH Rear Door Loom Install
Date:	29-Sep-17
Work Cycle Time:	49.0
Human:	#N/A
Notes:	
Linear Unit:	#N/A
Mass Unit:	#N/A

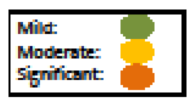
Mobility:



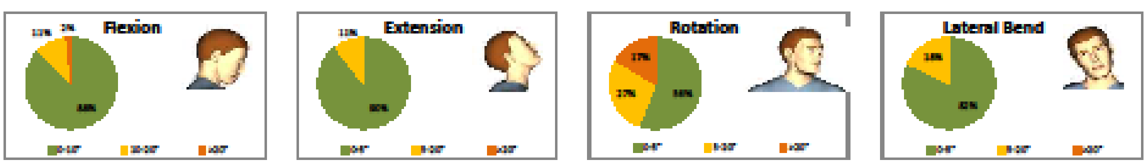
Percent of Work Cycle spent:



Joint Angle Summary: Time spent per work cycle in each posture range



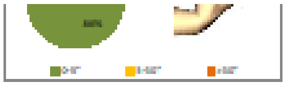
Neck:

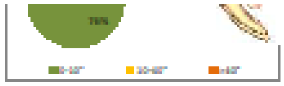


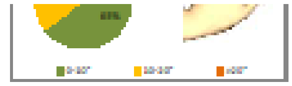
Back:

Left Wrist:

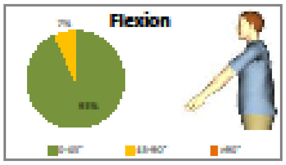
Right Wrist:

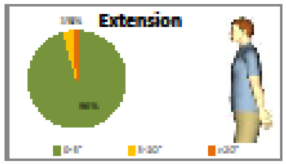


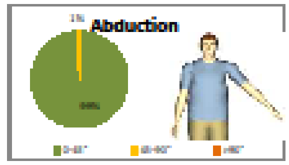


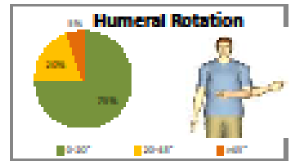


Left Shoulder:

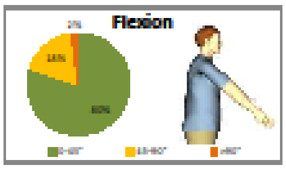


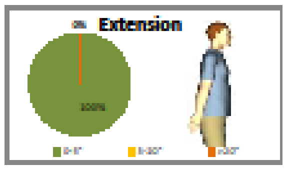


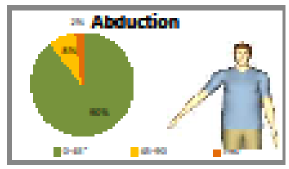


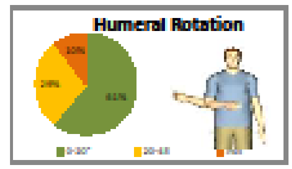


Right Shoulder:

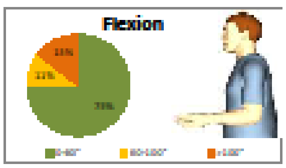




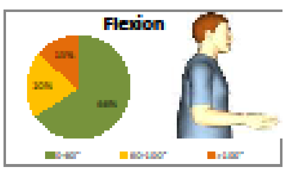




Left Elbow:



Right Elbow:



Working with both hands (kg)

Task	Load
tear_tape_from_harness	0.7
Apply_Force_Rh_Rear_Door_w_Wiring_0	5.1

Lift/Lower below 81 cm (kg)

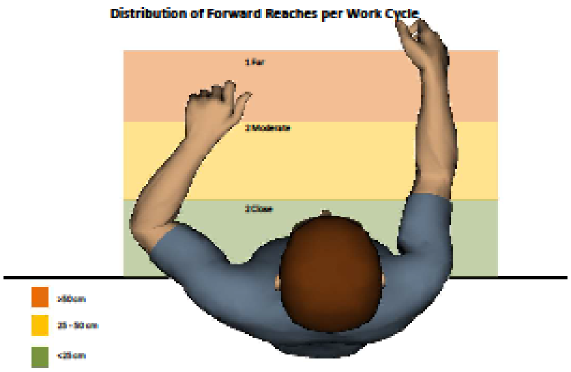
Task	Load
Move_to_clip_harness_tape	6.8

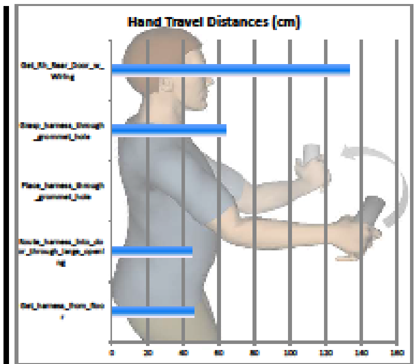
Lift/Lower above 81 cm (kg)

Task	Load
Open_Door	6.8
Move_to_clip_harness_tape	6.8
tear_tape_from_harness	0.7
Route_harness_into_door_through_large_opening	0.7
Pull_harness_to_seat_grommet	14.5
Apply_Force_Rh_Rear_Door_w_Wiring_0	5.1

Apply Force (kg)

Task	Left L	Right Load
Open_Door	0	6.8
tear_tape_from_harnes	0.4	0.4
Pull_harness_to_seat_g	14.5	0
Seat_clip_nearest_to_g	0	0.7
Seat_harness_clip_lowe	0	0.7
Seat_clip_b_pillar_shut	0	0.7
Seat_harness_clip_belo	0	0.7
Seat_clip_below_speak	0	0.7
Apply_Force_Rh_Rear_	0.7	0
Apply_Force_Rh_Rear_	3.5	3.5





Close Reaches (cm)

Task	Distance
Route_harness_into_door_through_large_opening	16.1
Place_harness_through_grommet_hole	16.1

Moderate Reaches (cm)

Task	Distance
Grasp_harness_through_grommet_hole	25.4
Get_Rh_Rear_Door_w_Wiring	28.9

Far Reaches (cm)

Task	Distance
Get_harness_from_floor	52.2

Hand Travel Distances (cm)

Task	Total travel Distance
Get_harness_from_floor	45.9
Route_harness_into_door_through_large_opening	45.2
Place_harness_through_grommet_hole	0
Grasp_harness_through_grommet_hole	68.6
Get_Rh_Rear_Door_w_Wiring	133.6
Total Hand Travel	297.9

Sample PDD

Job Description and Physical Demands

JOB CODE/TITLE: Steering Wheel Install
DEPT/ZONE:
CLAIM:

DATE: October 30, 2017
ASSESSOR:
CLAIM ADMINISTRATOR:

JOB OBJECTIVE: To install and secure the steering wheel.

JOB DESIGN: The employee currently works 8 hours per day Monday to Friday while on day-shift. While on afternoon-shift, the employee works 10 hours per day Monday to Thursday, and 8 hours on Friday. Shift-work is required and changes bi-weekly. Day-shift is from 7:00 a.m. to 3:30 p.m. Afternoon-shift is from 3:30 p.m. to 2:00 a.m (10 hour day) and 3:30 p.m. to 12:00 a.m. (8 hour day). The employee may be asked to work overtime periodically. During a 10 hour day the employee has breaks throughout the shift totaling 50 minutes, and during an 8 hour shift the employee has 40 minutes of breaks, not including lunch, which is 30 minutes in length. When the line is running at full production, the rate is approximately 65 units/hour with a cycle time of approximately 50 seconds.

VEHICLE MIX:

Cycle Time: 50 seconds.
Exertion Period: 25 seconds for vehicle 1/vehicle 2,
Absolute Recovery Period: 25-30 seconds.

DUTIES	DESCRIPTION
vehicle 1/vehicle 2vehicles: Obtain steering wheel	Retrieve steering wheel (4 lbs vehicle 1, 5 lbs vehicle 2, AFS 7.4lbs) from height adjustable/rotatable stock bin (5 rows of steering wheels, 10-55" reach). Walk 3-4m to retrieve 1 nut from stock rack (34" high). Scan steering wheel. Walk 1-2m to vehicle front left door. Open door. Time: 4 seconds.
Align and install steering wheel: Active Front Steering	Place steering wheel onto seat (28" high). Remove two plastic hubs from steering column at 40" and make two connections from steering column to steering wheel. Use both arms to place steering wheel into steering column (40" high, 12" reach). Hand-start nut onto steering column. **Time**: 7 seconds
Align and install steering wheel: Non Active Front Steering:	Route steering column wires through steering wheel and install steering wheel onto steering column (40-48" high, 22" into vehicle to centre of wheel). Hand-start nut onto steering column (40" high, 12" into vehicle). **Time**: 10 seconds.
Secure steering wheel to steering column.	Walk 1-2m to retrieve 21" right-angle torque gun with 6" extension socket (9.4 lbs) hanging from hook (52" high). Return to vehicle open front left door. Using torque gun, secure steering wheel to steering column with hand-started nut (40" high, 12" into vehicle - reach reduced to approx 10" due to gun length). **Time**: 5 seconds.

Note: Some cars are made right side drive. The exact job is done and another gun is provided on the other side.

DEMAND/ACTION			CHECK IF PERFORMED	DURATION (out of 50 second cycle time)	FREQUENCY (Rarely 1-5%, Occasional 6-33%, Frequent 34-66%, Constant 67-100%)	Job Code/Title: Steering Wheel Install		
						Claim:		
						DESCRIPTION		
STRENGTH	Lifting	One Hand				Object:	Torque guns	
						Weight Max.:	9 lbs / 8.5 lbs	
		Two Hands	X	5 seconds	Occasional	Weight Avg.:	9 lbs	
						Lifting Range:	To waist (40-44" high)	
	Carrying	One Hand	X	5 seconds	Occasional	Object:	Steering wheel	
						Weight Max.:	4 lbs / 5 lbs / 5.5 lbs/ 7.4 lbs	
		Two Hands				Distance	4-5m	
						Handles	Cylindrical	
	Push/Pull	One Hand				Object:		
						Distance		
		Two Hands				Force		
						Handles		
MOBILITY	Sitting							
	Standing							
	Walking		X	25 or 20 seconds	Frequent	4-5m stock to vehicle. Slowly walking with vehicle along assembly line.		
	Foot Activation							
	Twisting / Turning							
	Lateral Bending							
	Bending / Stooping							
	Crouching / Squatting							
	Kneeling							
	Climbing							
	Balancing							
	Jumping							
	Crawling							
	Running							
DEXTERITY	Reaching					Below Knee:		
	Right Hand		X	5 seconds	Occasional	Above Shoulder:		
	Both Hands		X	10 seconds	Occasional	In front of body:	Both - routing wires through steering wheel, seating steering wheel onto steering column	
	Either					Side of body:		
	Fine Finger Movement		X	5 seconds	Occasional	Routing wires through steering wheel, hand-starting steering column nut/bolt		
	Handling							
	Right Hand							
	Left Hand							
	Either		X	7 seconds	Occasional	Steering column nut+bolt		
	Gripping					Grip Type:	Palmar - both	Palmar - both+right
	Right Hand		X	3 seconds	Occasional	Object:	Torque guns	Steering wheel
	Both Hands		X	15 seconds	Occasional			
	Either					Object weight:	9 lbs / 8.5 lbs	4 - 5.5 lbs
	Hand/Eye Coordination		X	25 or 20 seconds	Frequent	Aligning steering column with tool, routing wires through steering wheel, installing steering wheel onto column, hand-staring steering column nut/bolt, securing steering wheel with torque gun		
	Foot/Hand/Eye							
POSTURAL DEMANDS	Neck					Range of Motion (in degrees):		
	Flexion		X	5 seconds	Occasional	10-20 degrees while securing steering wheel with torque gun		
	Extension							
	Rotation							
	Elbow					Range of Motion (in degrees):		
	Supination/Pronation		X	5 seconds	Occasional	Pronated left arm routing wire through steering wheel		
				5 seconds	Occasional	Supinated right arm holding steering wheel while routing wire		
	Flexion/Extension		X	5 seconds	Occasional	90 degrees left arm, 20-30 degrees right arm securing steering wheel with torque gun		
				2 seconds	Rare	Fully extended removing keys from ignition		
	Shoulder					Range of Motion (in degrees):		
	Flexion		X	15 seconds	Occasional	45 degrees both arms routing wires through steering wheel, seating wheel onto steering column, and securing steering wheel with torque gun (right arm only, left arm neutral)		
	Extension							
	Abduction		X	5 seconds	Occasional	45 degrees hand-starting steering column nut/bolt		
	Adduction							
	Rotation							
	Wrist					Range of Motion (in degrees):		
	Flexion							
	Extension							
	Deviation							
	Back					Range of Motion (in degrees):		
	Flexion		X	5 seconds	Occasional	30-40 degrees seating steering wheel onto steering column		
	Extension							
	Twisting/Lateral Bending							