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**ISB 2012 Visit
to the
Tanzania Training Centre
for
Orthopaedic Technologists
(TATCOT)**

Final Report

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Executive Summary

As EDC Project Officer and TATCOT Project Champion, I was given the opportunity to represent the ISB at TATCOT for a 3-week visit in October 2012. Objectives for the visit included strengthening our collaboration and determining the current status of the gait lab, the ISB's contribution to their biomechanics curriculum development, and specific administrative issues. Over the course of the visit, I learned about the administrative setup of the lab at TATCOT and within the greater community, current needs including lab equipment (camera repair and digital vector analysis cameras), staff training, teaching modules, and library resources, as well as TATCOT's strategies to expand their biomechanics programmes at both undergraduate and graduate levels and the management structure that would sustain these initiatives. Bart Koopman (Professor, University of Twente) and I were able to provide some instruction on upper-limb and spine biomechanics, gait analysis, and biomechanics research opportunities to staff and students. Together with several of the TATCOT staff, we were also able to identify potential opportunities to further develop our collaboration through annual visits by Bart as student thesis examiner and staff/student guest lecturer, connecting with academics in related biomechanics fields via Bart's professional network, and through TATCOT members' representation at our upcoming ISB2013 Congress. We outlined a concrete proposal by which TATCOT staff and students could attain ISB membership that is affordable and logistically feasible. Overall, the outcomes for the visit were above and beyond my expectations and I am optimistic that this collaboration will continue to benefit all contributing collaborators in future.

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Introduction

Background

The collaboration between the International Society of Biomechanics (ISB) and the Tanzania Training Centre for Orthopaedic Technologists (TATCOT) began in 2005 when Brian Davis, then ISB President, visited TATCOT and learned that the “grand vision” of Harold Shangali (TATCOT Principal) and Longini Mtalo (TATCOT Deputy Principal, Academics) was to install a gait lab to support teaching, clinical, and research initiatives. The University of Cape Town and Cleveland Clinic Foundation - with the support of Vicon and AMTI - generously donated the camera system and force platforms, respectively, which were installed in the newly constructed gait lab at TATCOT in late 2006.

Since then, the ISB has promoted the project through technical and financial support and, more recently, shifted its focus to working with TATCOT on the broader objective to further develop its biomechanics programme, for which the gait lab constitutes just one of many tools. Julie Steele (past-President) and I helped form a collaboration between TATCOT, the ISB, Roessingh Research and Development (RRD), and the University of Twente (abbreviated to TRUTI) in 2011 to foster this more comprehensive strategy to grow biomechanics in Africa. A Memorandum of Understanding (MoU) was composed by collaborators in June 2011 detailing specific objectives for the partnership. A comprehensive [history of the TATCOT project](#), including several partners participating in the collaboration, is published on the ISB website.

Our first opportunity to organize an in-person meeting between several key collaborating partners, including Harold Shangali (TATCOT), Joachim Moshy (TATCOT), Bart Koopman (University of Twente), Leendert Schaaek (RRD), Julie Steele (ISB), and myself, occurred in July 2011 at the ISB Congress in Brussels. At that time, we were able to learn from one another what the ISB and individual collaborators could contribute to the initiative, what recent technical issues had been resolved at TATCOT, and some general objectives around curriculum development for the future. Albeit brief, our TRUTI meeting and other interactions during the conference provided an encouraging introduction to the collaboration and promised productive progress in the coming 2-year period.

Over the following several months, moderate progress was made towards several of the goals we had set to accomplish. The common challenge of distance communication that accompanies such international collaborations presented uncertainty regarding status of our partners overseas, specifically with regards to targets that had been reached, barriers hindering progress, and whether requirements had changed due to newly emerging circumstances.

Visit Objectives

In April 2012, Harold Shangali invited me to TATCOT to address some gait lab research-project related issues. He outlined several specific wishes that I incorporated into a detailed agenda proposal. My overall objectives for the visit were to achieve clarity concerning TATCOT’s vision for their biomechanics programme and on-going association with the ISB. This would involve determining what progress had been made towards the project goals discussed at ISB2011 and those

included in our MoU, as well as understanding what obstacles were impeding developments and communication between collaborators. I furthermore hoped that by getting to know one another better and strengthening our relationship, we could address identified challenges, get TATCOT members more involved in the ISB community, and continue to move forward with respect to our common goal of growing biomechanics in the region.

Contributors

In order to make these discussions more effective, I suggested inviting Bart Koopman, who was interested in contributing to curriculum development and had assisted TATCOT students with their 2012 thesis projects. I also invited Kenneth Chelule, Moi Hospital Project Champion, who I believed could both benefit from and contribute to the ensuing discourse. Bart and Kenneth were both able to overlap their visits with mine in early October and spend time with several of the TATCOT staff, including Longini Mtalo, Fortunatus Gitarda, Joachim Moshy, and Harold Shangali.

Visit Outcomes

Visitors and Dates

Name and Position	Date
Andrea Hemmerich, ISB-TATCOT Project Champion, ISB-EDC Project Officer	October 1-19, 2012
Bart Koopman, TRUTI collaborator	October 7-14, 2012
Kenneth Chelule, ISB-Moi Hospital Project Champion	October 15, 2012

Gait Lab Overview

Who's Who?

Harold Shangali, TATCOT Principal, teaches much of the biomechanics content to the TATCOT students. He is committed to the development and long-term sustainability of a biomechanics programme within the TATCOT training courses and is therefore focusing his efforts on procuring and educating a dedicated team of academics, clinicians, and researchers. Future initiatives include the expansion of the current prosthetics and orthotics (P&O) courses to include a graduate-level programme. Several staff members are currently upgrading their qualifications to make up this team by means of the enabling environment created by Harold.

The previous gait lab manager, **Joachim Moshi**, was encouraged by Harold Shangali to expand his theoretical knowledge in the field of P&O in order to be more effective in the gait lab and as part of the TATCOT biomechanics teaching/research staff. He began the 3-year full-time Diploma Course in Orthopaedic Technology at

TATCOT last year in October 2011 (he had previously completed their Wheelchair Technology Certificate), and therefore had limited time for managing the lab in the 2011-2012 academic year. His former training also includes six months at the University of Strathclyde where Harold Shangali has a close relationship with Professor Norman Jacobs.

A new lab manager, **Fortunatus Gitarda**, was hired this year. Although Fortunatus has minimal experience in the gait lab, he has completed the TATCOT BSc Degree in P&O and is interested in pursuing an academic career in P&O biomechanics (or similar). He began his gait lab training during my visit with support from Joachim, Longini Mtalo, Bart Koopman, and me and is expected to spend approximately 50% of his teaching responsibilities on lab initiatives (with the remaining 50% dedicated to lecturing).

Longini Mtalo, Deputy Principal for Academics, is currently upgrading his academic qualifications through the completion of an MSc degree in Norway where he spent most of his time in a gait lab with almost identical equipment to that at TATCOT (Vicon cameras, AMTI force platforms). He spent the entire 2011-2012 academic year overseas, and therefore was limited in the support he could provide to TATCOT gait lab staff at that time. He is currently back in Moshi and expects to complete his thesis in early 2013.



Gait lab training for the new lab manager.

Clockwise from top-left:

Fortunatus and Longini measuring anthropometrics;

Joachim explaining the purpose of the L-frame for calibration;

Longini interpreting Vicon software with Fortunatus at the computer and Joachim observing;

Joachim as subject with Longini and Fortunatus collecting data in the background.



An additional 5-10 members make up the teaching staff concerned with the biomechanics part of the P&O programme, focusing on clinical and/or theoretical knowledge. These staff attended two lectures on “Biomechanics of the upper limb amputee” and “Biomechanics of the spine,” as well as a gait lab demonstration of a below-knee amputee – data collection and analysis - conducted by Bart Koopman. In addition, I presented a session entitled, “Biomechanics research: What are the possibilities?” to provide a general overview of the field to those staff who had little research experience and to introduce potential gait lab research investigations based on student projects from previous years. These sessions were presented in English, the language of instruction at TATCOT.





Bart Koopman (far left) with TATCOT staff, including Harold Shangali (far right).

Current and Future Use of the Lab

The gait lab is primarily being used for **teaching** purposes at this time. Two final-year BSc students completed thesis projects using the lab last year (July 2012) and this year's students will also be given this option for their research projects. During our initial sessions in the lab, I was able to help Longini and Fortunatus identify some of the data analysis issues within Vicon's Polygon software that may have contributed to uncertainty with their interpretation of the results. Reprocessing the previously collected data will not only reinforce their understanding of the system, but also improve their capacity to teach gait analysis to the students.

A formal lab component for the biomechanics course(s) will be introduced this year. During clinical training sessions with P&O patients, students will invite their patients to participate in pre- and post-fitting gait assessments. This will allow the students to observe the effects of their practical work on each patient's gait. This will also be used as a means by which to expand the TATCOT database for future research studies.

P&O BSc students' ISB biomechanics training.

Top: Students attend Bart Koopman's background lecture on gait analysis.



Bottom left: Kunthea Kim, BSc student and volunteer subject, has Vicon markers attached to knee-ankle-foot-orthosis (KAFO).



Bottom right: Longini Mtalo (standing) teaches in the gait lab.



Once the expertise of staff members is sufficient to benefit clinicians and patients, the lab use will be expanded to incorporate **clinical initiatives**. Longini Mtalo, for example, would like to establish a clinic for children with cerebral palsy (CP), for whom gait assessment could strengthen diagnosis and treatment options. TATCOT's association with and proximity to the Kilimanjaro Christian Medical Centre (KCMC) will also provide potential for clinical assessment of patients.

Research investigations beyond the scope of the undergraduate student projects are also envisioned for the TATCOT gait lab. Studies may be conducted by staff/students exclusively within the TATCOT/KCMC community, or may involve external researchers. P&O academics from overseas have previously shown interest in working with TATCOT to develop appropriate technology. Currently, Harold Shangali is working with Jan Andrysek at the University of Toronto, to set up a one-year field test of Andrysek's low-cost knee prosthesis (LC Knee) on eight patients. The gait lab could provide additional research opportunities for these types of initiatives.

One challenge that the TATCOT team faces in building their research capabilities is the potential to draw upon interdisciplinary expertise. With further exposure to all stages of the research investigation, a growing need for knowledge in other disciplines, such as statistics and engineering, will arise. As part of the KCMC, Tumbani University, and ISB communities, access to these expertise should be practicable.

Lab Equipment – Current Status and Future Aspirations

Camera Repair:

At the time of my visit, one of the six cameras was not functioning properly. A problem occurred shortly after Vicon upgraded the cameras following an initial camera repair. Five cameras were replaced and reconfigured separately from the original camera that had the problem. It may have been possible to readjust all camera settings in order to rectify the problem. As Joachim Moshy was most familiar with the technology, he agreed to work with Fortunatus and Longini in addressing this issue with the support of Vicon staff and/or Leendert Schaaek (RRD). Data collection with the five functioning cameras was still feasible.

Electromyography (EMG) Donation:

In May 2012, Brian Davis contacted me regarding an offer by an ISB colleague in Germany to donate an EMG system to TATCOT. In July I connected with Harold Shangali via e-mail to extend this offer and suggest further discussion. While I was not able to continue the discussion remotely, the TATCOT team did have a chance to consider and discuss amongst themselves whether they could accept the offer. When I arrived in Tanzania, they informed me that they appreciated the offer and hoped to integrate EMG equipment into their lab setup in the future; however, their priorities were to further enhance their expertise using the existing equipment and, rather, to obtain additional equipment that would reinforce their theoretical understanding of gait analysis with regards to current lab operations. With this in mind, a request was made for specialised digital video cameras (as outlined below).

Additional Equipment to Complement Existing Operations:

During his year in Norway, Longini benefitted from the frontal and sagittal plane digital videos that enhance visualization of the Vicon and force platform data. He suggested the superimposed image of the subject with the resultant force vectors (direct video vector analysis) would further help TATCOT staff and students interpret the clinical data and improve their overall grasp of biomechanics concepts. I suggested the ISB council or wider community might be able to assist with acquiring the appropriate digital video cameras.

Harold was also interested in research on energy consumption during gait in various subject groups and suggested a treadmill might be used to acquire this type of data. Further exploration of this research area is required.

TRUTI Collaboration – Vision for the Future

TATCOT Staff Training

In addition to continual “in-house” gait lab training, Longini suggested that Fortunatus should take advantage of some gait biomechanics short courses. These intensive multi-day sessions would expand his understanding of the applications of the current system to relevant P&O biomechanics issues.

In order to obtain the greatest benefit from such a course, a stronger knowledge foundation would be required, which I expect Fortunatus will acquire through continual practice with the system, specifically, regular teaching sessions and patient assessments (assisted by Longini and Joachim). Once Fortunatus has an

acceptable basic understanding of the system, the ISB could look at options on how to support this proposal.

Biomechanics Curriculum Development

The TATCOT team has undertaken a number of initiatives to develop its biomechanics programme and expertise. In addition to several brief visits by ISB representatives, short- and long-term staff exchanges which were supported by Fredskopset, Norway, built capacity around practical and clinical P&O biomechanics.

The TATCOT staff members have expressed interest in further strengthening their *theoretical biomechanics* knowledge through the expansion of the current TRUTI collaboration. Harold has invited Bart to return on an annual basis for a 3-year term to provide staff and student seminars in specific fields of biomechanics (e.g. similar to those given during our visit), as well as to act as external examiner for students' thesis projects. Collaborators recognized that Bart's expertise in biomechanical engineering will provide one piece of the required biomechanics scholarship; as such, preliminary discussions took place around inviting other colleagues of Bart's with more clinical expertise in related fields, such as rehabilitation engineering, to join the collaboration. It was furthermore recognized that expanding the existing collaboration and proposing regular visits would have financial and administrative implications; all collaborators agreed to investigate significance and solutions around this agenda.

TATCOT at ISB2013

During our final meeting, we discussed the potential for TATCOT members to attend the upcoming ISB congress in Brazil. Longini was interested in presenting some of his Master's research, while Fortunatus could also represent TATCOT at the EDC Workshop that I will organize. Participation in the workshop will, no doubt, contribute to awareness within the ISB community around barriers to biomechanics research and development in EDC regions.

Assuming that other members of the TRUTI collaboration will also attend ISB2013, TATCOT's presence will provide further opportunity for face-to-face discussions about future initiatives.

It is anticipated that financial costs associated with travel will be covered by both TATCOT and the ISB via the EDC Congress Travel Grant. Proposals/applications will be presented to the ISB and the TATCOT Advisory Board.

ISB-TATCOT Administrative Issues

ISB Membership for TATCOT Staff and Students

In order to accommodate logistical and financial conditions for those staff and students who wish to become ISB members, a proposal for an institutional membership and was developed by Harold Shangali, Longini Mtaló, Fortunatus Gitarda, and myself. This "custom" membership and fee structure is intended to facilitate greater membership within the TATCOT community.

Operation and Maintenance of Gait Lab

As lab manger, Fortunatus will be in charge of daily operations and maintenance of the lab under the supervision of Longini Mtalo and Harold Shangali. Fortunatus and Longini, for example, have assumed responsibility for repairing the camera that was not functioning at the time of my visit.

Financial resources for the lab are currently acquired through the **TATCOT school budget**, since at this time it is used primarily for teaching purposes. TATCOT is organized under the Tanzanian Ministry of Health and Social Welfare, represented on the TATCOT Advisory Board, which reviews the school budget annually in January.

The following initiatives are planned to gain future revenue for lab operation and maintenance costs:

- *Fees from patients/clinicians for clinical assessment:*
Awareness about the applications of gait analysis will be created within the TATCOT/KCMC community through seminars/workshops presented at the weekly clinical conferences.
- *Fees for research projects involving the gait lab:*
In addition to potential research opportunities at the local and regional levels, TATCOT is collaborating with a number of international researchers on projects based at KCMC (e.g. KCMC-Duke University collaboration) and TATCOT (e.g. the Jan Andrysek, University of Toronto, LC Knee testing; visiting lecturers from Strathclyde University). It is expected that the gait lab facilities will be an important resource for these researchers to support high-quality, quantitative assessment of clinical devices designed for the developing world. These internationally-funded research investigations would, furthermore, have a greater capacity for financial contribution to lab operations and maintenance.

Harold anticipates another five years before the gait lab is financially self-sustainable.

Library Resources

The TATCOT staff would like to augment their library resources with a number of professional books and greater access to scientific journals. A list of books they wish to acquire, together with those recommended by Bart Koopman and me, was presented to the ISB-EDC Committee following the visit to produce ideas on how best to obtain these materials.

Some of the TATCOT staff members have access to a number of biomechanics-related electronic journals through the [WHO-HINARI Programme](#); however, certain relevant journals appear to be absent from this list. As Longini's HINARI login access was inactive during the period of my visit, confirming which additional journals could be added to the TATCOT resource library will require further investigation. Since the ISB is working with Elsevier to explore options for journal access to under-resourced academic institutions (e.g. in developing countries), we will continue to work together to help secure the required material.

Evaluating Progress of the ISB-TATCOT Collaboration

Formal reporting of ISB-supported initiatives at TATCOT was only briefly discussed; it was recognized that the TATCOT team is going through a transition period with experienced staff in various stages of academic advancement (e.g. Longini is in the final stages of his MSc degree, Joachim is midway through his P&O Diploma programme) and new staff (Fortunatus) still in training. I requested Fortunatus to submit a brief report around May 2013 that could be included in ISB council members' annual report. The report could include any accomplishments and performance indicators relevant to our cooperative objectives, such as (but not limited to):

- The number of students and staff who benefitted from the gait lab for clinical and/or academic work;
- The number of patients/subjects who were assessed in the gait lab;
- ISB membership interest within the TATCOT community;
- Update on camera repair and lab equipment procurement;
- TRUTI collaboration developments;
- TATCOT representatives who plan to attend ISB2013.

A more detailed strategy to evaluate the ISB-TATCOT collaboration should be designed by partners once the TATCOT team is further established; the upcoming ISB congress (August 2013) may be an appropriate time for such a dialogue.

Extending the Regional Biomechanics Community beyond TATCOT

Staying at the Shangali residence gave me the opportunity to meet some of his family, including his eldest son, Rodrick, who had just completed his undergraduate engineering degree at the University of Dar-es-Salaam. Rodrick completed his final year research project on the design of a wheelchair-tricycle attachment with much of the research, product fabrication, and user testing conducted at TATCOT. Since Rodrick is also interested in continuing with graduate studies in the biomechanics/biomedical engineering field, I encouraged him to attend an upcoming ISB congress; we are currently corresponding by e-mail regarding requirements and abstracts. Rodrick's attendance at an ISB congress could conceivably create awareness about biomechanics research and ISB opportunities within the engineering community in other parts of Tanzania.

Kenneth Chelule had limited time to travel to TATCOT from Kenya; however, the day that he spent there permitted me to gain a better understanding of the status of the gait lab project at [Moi Teaching and Referral Hospital in Eldoret](#). More importantly, Kenneth was able to engage in constructive discussion with Longini regarding the administrative structure of TATCOT's biomechanics programme, including explicit consultation about pitfalls in setting up the gait lab and how they were/will be overcome. Although I was only able to spend the morning with Kenneth, I am optimistic that the knowledge he gained, together with his experience in this field, will enable him to work with his colleagues at Moi Hospital to reorganize their management team in order to ensure long-term sustainability of the project.

I furthermore believe that Kenneth's research experience and access to regional information and resources through his current professional responsibilities could be beneficial to the TATCOT team in future. I was delighted that Longini was able to make his acquaintance and that a connection was established.

Conclusions

Within the healthcare profession, many frameworks have been developed to measure project outcomes and overall impact of programmes such as the ISB-supported EDC projects. Although we have not had the opportunity to work with stakeholders to adapt or redesign such a measurement system appropriate for the TRUTI collaboration (either at ISB2011 or during my TATCOT visit), I would like to integrate some of the broader concepts from literature with the specific objectives defined in our MoU to summarize project progress and challenges.

Progress with regards to objectives discussed at ISB2011 and within the MoU has primarily been achieved in the area of teaching and educational programmes, both for staff and students. A core team of TATCOT instructors competent in biomechanics is in place, with knowledge capacity concerning gait analysis now growing through in-house training. The curriculum has been structured to extend this knowledge to students, as well as to increase the TATCOT database for comparison of subject groups.

Two student research projects completed last year further provided a learning opportunity, also for staff, on the comprehensive research process and problem solving during data analysis and interpretation stages. An increased research potential has been created through staff academic training (primarily facilitated by Harold Shangali) and our TRUTI collaboration; in particular, Bart Koopman has demonstrated his commitment to skills development, as external advisor to TATCOT students, and to possibly expanding the knowledge network by involving several colleagues.

Progress towards the use of the lab for clinical assessment has been limited since staff members are still in the process of developing adequate skills and knowledge of the equipment. The administrative/management structure is in place, however, to sustain current operations with minimal support from the ISB over the next ~5 years. This would provide the time necessary to develop local capacity, move forward with clinical biomechanics goals, and ultimately become completely self-sustainable.

In my observation over the years that I have been involved with TATCOT, progress is typically achieved through in person collaboration, rather than remote and independent efforts, which is typical of any complex, interdisciplinary project and perhaps intensified due to regional cultural conventions. The greatest challenge that I anticipate in moving forward is, therefore, regular distance communication to facilitate advancement in technical issues (e.g. equipment repair), curriculum development (e.g. procuring library resources), and capacity building (e.g. TATCOT representation at ISB2013).

One of my primary objectives for this visit was to further develop the relationship between the ISB and TATCOT with the intention of ultimately fostering the growth of

biomechanics in this region of Africa. Strengthening trust between our organisations should furthermore provide a basis for regular communication and project updates, including both successes that we wish to share, as well as challenges with which we may need further support from one another or the larger community.

While I talk in broad terms about the growing connection between organisations, the trust developed in these relationships naturally is in the hands of the people involved. Spending almost three weeks in Moshi allowed me to get to know those people who have invested the greatest stakes in the TATCOT biomechanics programme; I have a much better understanding of what their personal motivations are and their long-term commitment to this academic field. Having had some time - albeit limited - to work together (rather than simply talk about plans) allowed us all to learn about one another's expertise and where each of us could best contribute to projects in future. I feel (and I hope that my colleagues and now friends whom I met in Tanzania would agree) that each of us is committed to contributing to our common goals and has unique skills to do so effectively. I am confident that the collaboration between TATCOT, the ISB, our colleagues in the Netherlands - and potentially other partners - will become stronger and more proficient over time resulting in positive and rewarding achievements for all involved.



Lunch at TATCOT. Left: Fortunatus, Longini, Andrea, & Harold. Right: Longini, Fortunatus, and Harold with Andrea's husband, Christopher, and son, Frederick.

Recommendations for the Future

In order for our collaboration to expand and evolve, I believe communication and regular visits between partners are essential. While it is inevitable that representatives from our various collaborating groups will come and go over the duration of such a long-term project, consistent project champions from each group will facilitate progress by maintaining institutional knowledge. Clearly defining short-term projects, for which collaborators' roles and external funding is identified, could help us to achieve these goals.

Acknowledgements

I would like to thank the members of the ISB-EDC Committee for supporting this visit and providing invaluable feedback regarding this initiative. I am also grateful to my fellow TRUTI collaborators, in particular my hosts at TATCOT, for all their contributions throughout this project.

Finally, I would like to acknowledge the reviewers listed below who presented comments and recommendations for this report.

Reviewers

ISB

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