

[5] "Erich Hecke." *The MacTutor History of Mathematics Archive*. 10 Apr 2006, 02:18 UTC. 29 Apr 2006, 10:11 <<http://www-history.mcs.st-andrews.ac.uk/Mathematicians/Hecke.html>>.

[6] "Felix Klein." *Wikipedia, The Free Encyclopedia*. 23 Mar 2006, 14:05 UTC. 29 Apr 2006, 18:21 <[http://en.wikipedia.org/w/index.php?title=Felix\\_Klein&oldid=45104808](http://en.wikipedia.org/w/index.php?title=Felix_Klein&oldid=45104808)>.

[7] "Henri Poincaré." *Wikipedia, The Free Encyclopedia*. 25 Apr 2006, 15:52 UTC. 29 Apr 2006, 18:21 <[http://en.wikipedia.org/w/index.php?title=Henri\\_incar%C3%A9&oldid=50101536](http://en.wikipedia.org/w/index.php?title=Henri_incar%C3%A9&oldid=50101536)>.

[8] Koblitz, Neal, *Introduction to Elliptic Curves and Modular Forms*, Graduate Texts in Math. No. 97, Springer-Verlag, New York, 1984. Second edition, 1993.

[9] "Louis Mordell." *Wikipedia, The Free Encyclopedia*. 11 Apr 2006, 10:19 UTC. 29 Apr 2006, 18:12 <[http://en.wikipedia.org/w/index.php?title=Louis\\_Mordell&oldid=47934311](http://en.wikipedia.org/w/index.php?title=Louis_Mordell&oldid=47934311)>.

[10] "Srinivasa Ramanujan." *Wikipedia, The Free Encyclopedia*. 28 Apr 2006, 13:12 UTC. 29 Apr 2006, 18:13 <[http://en.wikipedia.org/w/index.php?title=Srinivasa\\_Ramanujan&oldid=50577070](http://en.wikipedia.org/w/index.php?title=Srinivasa_Ramanujan&oldid=50577070)>.

[11] "Taniyama–Shimura theorem." *Wikipedia, The Free Encyclopedia*. 18 Apr 2006, 02:36 UTC. 29 Apr 2006, 18:11 <[http://en.wikipedia.org/w/index.php?title=Taniyama%E2%80%93Shimura\\_theorem&oldid=48939074](http://en.wikipedia.org/w/index.php?title=Taniyama%E2%80%93Shimura_theorem&oldid=48939074)>.

[12] W. Stein, *The Modular Forms Database*, 2004 <<http://modular.fas.harvard.edu/Tables>>.

[13] "Andrew Wiles." *Wikipedia, The Free Encyclopedia*. 3 May 2006, 19:57 UTC. 3 May 2006, 20:29 <[http://en.wikipedia.org/w/index.php?title=Andrew\\_Wiles&oldid=51410425](http://en.wikipedia.org/w/index.php?title=Andrew_Wiles&oldid=51410425)>.

[14] "Yutaka Taniyama." *Wikipedia, The Free Encyclopedia*. 31 Mar 2006, 17:47 UTC. 29 Apr 2006, 18:09 <[http://en.wikipedia.org/w/index.php?title=Yutaka\\_Taniyama&oldid=46343740](http://en.wikipedia.org/w/index.php?title=Yutaka_Taniyama&oldid=46343740)>.

# The Hungarian School of Pianism: The Makings of a Pianist

Sandra Doan

.....  
*Texas Christian University*  
*2800 South University Drive*  
*Fort Worth, Texas 76129*  
*www.tcu.edu*  
*s.v.doan@tcu.edu*

*Liszt Ferenc Academy of Music*  
*Liszt Ferenc tér 8*  
*H-1061 Budapest*  
*www.lfze.hu*  
*Adviser: Prof. György Nádor*

.....  
*Hungary has produced the greatest number of successful concert pianists per capita in the world in the last century. Those trained inside of Hungary can be immediately identified by their distinctive approach to the piano, the sound created from the piano, and their technical prowess. Several "piano schools" exist in the world today; their individual styles are often affiliated with their national histories and the character of their different peoples. To classify the unique approach to pianism in Hungary, this paper will trace how the country's history and connection between Western and Eastern Europe has developed its ideals of piano performance, demanding both stylistic accuracy in performance practice, musical sensibility, and technical perfection. Then, it will examine the educational process of training a young pianist and why it is so effective. The last part of this paper will briefly analyze a set of pieces written by Franz Liszt, Deux Legendes. Liszt is credited with founding the music school in Budapest, and his ideas influence the way music is taught today. By examining these compositions, this paper will also show how his musical ideas reflect those still emphasized today in the Hungarian school of pianism.*

## Introduction

*In the past century, Hungary has produced the greatest number of performing pianists per capita in the world. Pianists such as András Schiff, Zoltán Kocsis, and Georges Cziffra have virtually become household names. The line of prominent musicians can be followed along the long tradition of Hungarian musical life, and the superior level of pianism is the result of the highly developed and advanced musical education system which has today become institutionalized into the Hungarian school of pianism.*

Several distinctive “national” piano schools exist today and can generally be identified when watching or listening to any performer. The style of pianism particular to any country can often be associated with the music being composed there, the nation’s historical context, and the national character of a people. The Russian school, for instance, is characterized by technical brilliance and perfection, moodiness, passion, and a slight aloofness from the audience, as typified by its composers and people. The French school is typically marked by elegance, finesse, and lightness of touch. The German piano school is full of weight, substance, and warmth. Pianists schooled in the United States are generally creative and individual in their interpretations, confident, and slightly self-aware. These characteristics are passed down through generations of private studio lessons and formal university level training.

Hungary has also developed its own system of teaching and perspectives on

piano performance. This has resulted also in a unique approach to pianism, with a distinctive sound and approach to the piano repertoire.

## The Hungarian School of Pianism

Zoltán Kocsic once remarked, “*One can immediately recognise pianists from the Hungarian school as, before they’ve even placed their hands on the keyboard, they are given away by the way they hold themselves in front of the piano*”.

The Hungarian piano school can be attributed to its geographical location, which has affected its political history as well as cultural heritage. Throughout its history, Hungary has served as a buffer zone between Western and Eastern Europe, enjoying and retaining the cultural influence of both spheres through historical changes while maintaining its own national identity. The Hungarian style of teaching and performance has also been influenced heavily by both Western Europe and the former Soviet Union.

## Development of the Hungarian Piano School in a Historical Context

After years of unrest under Turkish Ottoman rule and as a province of the Austrian Hapsburg Empire, the Compromise of 1867 and subsequent Dual Monarchy finally brought Hungary into a Golden Age, its only one in 1001

years of existence. The Austrian empire turned into the Hapsburg’s Austro-Hungarian Empire, and Hungary enjoyed privileges as equal partner to Austria, with Budapest as the counterpart capital to Vienna, until 1918 and defeat in World War I. It was during this time that a cultural rebirth began in Budapest. While the city underwent major construction of buildings and renovations as a second capital of the empire, musical life also flourished. The birth of the Hungarian musical tradition present today can be traced to this time, marked by the emergence of Franz Liszt (1811-1886). Though most of his life was spent outside the country, in Austria, France, Germany, Switzerland, and Italy, Liszt proudly claimed his Hungarian heritage and split his time among other cities with Budapest in the final years of his life, helping to establish the Liszt Ferenc Academy of Music, then called the Royal Academy of Music.

Liszt can be considered the founder of the Hungarian piano school, which among other things, emphasized stylistic correctness. As a composer himself, Liszt appreciated the intent of other composers. In his own works for piano, every detail is denoted in the musical score – phrases are marked, articulations specified, notes on how to play or the sound to create given. Such particularity suggests specificity to the performer; this habit carried into his interpretations of other composers and to his teaching. As a pianist, he also had an extraordinarily large piano repertoire, spanning from Scarlatti in the Baroque time to his own revolutionary works,

and despite his elegant and otherworldly mannerism, he was a musician first. As a cosmopolitan figure and connected with the major composers and musicians of his day, Liszt was also knowledgeable about and respected the musical movements of his day, paying attention especially to Chopin, Berlioz, Wagner and Verdi. Devotion to the intentions of the composer remains a focal point in Hungarian piano education today.

However, the Vienna-Budapest connection offered other benefits to the classical musical life in Budapest. Freedom of movement into Vienna, the musical center of the world with claims to the great classicists – Haydn, Mozart, and Beethoven – meant exposure to the musical finesse and refinement of Western Europe. Hungary’s Golden Age under the dual monarchy and its cultural growth took a Western turn, and a classical music tradition was cemented in Budapest as well, especially after the Music Academy was established.

From 1918, when Austria-Hungary was split, and Hungary lost 40% of its land area, to 1947, when Communism officially came in the form of a puppet government of the Soviet Union under the Hungarian Socialist Workers Party, Hungary was besieged again by shifting unrest, with communists first filling the vacuum, followed by fascists and Nazis. After both World Wars I and II, Hungary was devastated by hundreds of thousands of military and civilian deaths and near total destruction of Budapest. By the 1945 surrender of German and Nazi Hungarian troops, 75% of the homes, historical

buildings, and churches had been destroyed or severely damaged, including all the Danube bridges linking Buda and Pest. Despite these difficulties, though, with typical Hungarian perseverance and resolve to maintain its national identity, world class pianists (as well as composers and conductors) educated at the Royal Academy of Music were pouring out of Hungary – György Sébok, Georges Cziffra, Géza Anda, György Sándor, Lili Kraus and Annie Fischer in addition to Sir Georg Solti and Maestro George Szell – and making known the presence of Hungarian musicianship.

By 1947, Hungary had become a satellite of the Soviet Union. In the time between 1947 and 1990, Hungarians endured (and enjoyed) varying levels of autocracy, depending on who was in power, though Hungary by the 1970s, was already ahead of other Eastern bloc nations by liberalizing the consumer market. However, as in most other satellite states, Hungarians had two primary ways to “escape” – through excellence in either music or in sports. It was during this time that Hungary found success in the hockey arena, the soccer fields, and in other sports, winning major tournaments and medals during Olympic games. It is also under Communism that Hungary educated and produced such great musicians today as Zoltán Kocsis, Dezső Ránki, András Schiff, and Jenő Jándó, all students in the famous class of the pedagogue Pál Kadosa.

It was in this time that the modern Hungarian methods of teaching solidified. With its proximity and connection to

the Soviet Union, the Russian school of pianism influenced the way music came to be taught. Besides the Music Academy in Budapest, Hungarian musicians had access to the great Russian music conservatories, particularly the Moscow Conservatory of Music, which was churning out talented pianists like a factory. From the Russian school, the technical parts of playing the piano became very important, though it would be taught in Hungary differently, to be discussed later in the paper. The Russian conservatories had, and still have, pianists repeatedly practicing scales, chords, and arpeggios as well as difficult technical passages in the most difficult works of the piano literature. The trend of flawlessness in performance also appeared by the 1970s, and only pianists with the greatest technical skill could create a performance career. This emphasis on the mechanics of playing piano is evident in current Hungarian piano training and has become part of both private studio lessons and in formal education in the classroom. At the same time, with the typical resolve of the Hungarian character, musicians held onto their musical heritage from Liszt, national identity with their folk music and new music coming from Béla Bartók and Zoltán Kodály, and the poetic musical ideals of a refined Western Europe of which Hungary was once a powerful member.

### A Distinct Sound

This resulted in a distinctive Hungarian method of pianism that uniquely blends technical problem-solving with musical

speaking and poetry, with some emphasis placed on Hungarian music. In the Hungarian school of pianism, one of the most important musical aspects is a knowledge of correct performance practice for not only the different styles (Baroque/Rococo, Classical, Romantic, Twentieth century, and Modern) but for the major composers within each style. Apart from reading the score and noting specific directions for ornamentation, pedaling, and tempi, this requires a general knowledge of a composer’s whole repertoire, his intentions in writing, his historical and personal perspectives, and how he notates. In addition, to perfectly perform such piano literature, as became necessary in the increasingly competitive world of pianists, technical problems must be worked out, with emphasis on finger dexterity, the ability to play difficult passages, and create different sound worlds with the same 88 keys. The Russians did this with repetitions of scales and technical exercises, separating technique from creating music. Hungarian students are given various difficult works to study and find technical solutions to musical problems. By asking, “How can I get this particular sound?” – or feeling, or to create lyricism out of notoriously difficult passages – the student is forced to come up with a technical way to solve the problem. This takes care of both technique *and* musicality.

As a listener, then, what are the results of this Hungarian piano school, distinguishing a Hungarian pianist from the scores of others? Hungarian pianism is characterized by nearly flawless technical

execution of difficult pieces. There is a strong sensitivity to sound, developed through years of ear training and private lessons, and a penchant for a transparent clarity and warmth of sound juxtaposed together, never with sharpness but elegant and light. The emphasis on stylistic correctness goes so far as to differentiate sounds between such close composers as Haydn and Mozart, Schumann and Brahms, or even different time periods of each composer. Pianists well-trained in this school have a clear and organized sense of musical architecture and a sense for the plasticity of melodic and harmonic shape as well as for dealing with polyphony, every voice singing. Besides the distinct sound, performances are exemplified by a confidence at the piano that is yet without unnecessary movement or bravura.

### Professional Piano Training

Under Soviet organization, an educational system was instituted that began serious musical training at a very early age, resulting in the quality production of world-class musicians, if those identified as “musically talented” chose to go that route. With serious specialized musical studies beginning in early adolescence, Hungarian music students today far exceed their American counterparts preparing to enter universities.

In primary music schools, students aged six to fourteen, in addition to basic classes like mathematics and reading, are taught

privately in instrument lessons and begin simple ear training, identifying intervals, learning solfège and choral music under the Kodály method. Zoltán Kodály was a Hungarian ethnomusicologist who worked with Béla Bartók to collect and systemize Hungarian folk songs. He also developed a highly regarded music education method used widely in both Hungary and throughout the United States using solfège, hand symbols, and folk music.

At the age of fourteen, these students may elect to enter a conservatory, or music high school, if they are accepted after auditions. The prominent high school in Budapest, the Bartók Béla Conservatory, feeds into the Liszt Ferenc Academy of Music and is generally acknowledged to be the most vigorous program in the country. At the conservatory, musical training is intensified with the intent of preparing students for a professional career. Many schools also offer programs for younger students who may audition and enter into a pre-class for extra training through private teaching.

The pre-class begins immediately to improve and perfect technique and to gain familiarity with all major styles and their major composers and works, carrying on the traditions of Liszt. Students quickly and meticulously work through the Bach two and three part Inventions, Sinfonias, and Preludes and Fugues, Haydn and Mozart Sonatas, Chopin Etudes, Mazurkas Polonaises, and Preludes, Liszt, Bartók Mikrokosmos, and etc. These pieces are often revisited at the university level with greater maturity but also with the

foreknowledge of stylistic elements. This work continues through the conservatory years with their private teachers.

The conservatory requires also lessons in chamber music and classes in music history, theory, solfège, and to emphasize national music, folk music and Hungarian music history. A great focus is placed on developing the musical ear, to aid in theoretical as well as musical analysis. In the solfège class at the Bartók Béla Conservatory, students each week must accompany themselves on a song, sing one voice while playing the other parts in motets by Orlando Lasso, Bach chorales, and examples from *A Thousand Years of Choir*, and write down diction, playing and memorizing almost immediately the selections from four-part Bach chorales and examples from twentieth century music. Thus, by the end of these four to six years in conservatory, music students, and pianists in particular, have not only amassed an enormous repertoire but also formed a solid foundation for university work, a professional career, and true musicianship.

There are music faculties at the universities in Pécs, Debrecen and Szeged, among others, though perhaps the most famous and prestigious music program is the Liszt Ferenc Academy of Music, formerly the Royal Academy of Music. The Academy offers a five-year program that leads to a Master's degree in performance and pedagogy, a three-year doctoral program, and part-time studies. Apart from private studio lessons and chamber coachings, classes continue in the tradition of the Hungarian style

of piano teaching with methodology, which explains technical functions of the muscles, hand positions, postures, and other physical elements of pianism to help with proper relaxation and improve technique, music history, piano literature, pedagogy, and other courses. The most important work in all these levels of music education, though, is in the one-on-one private lessons with piano professors. At the end of their studies at the Liszt Academy, pianists are well-qualified to teach and perform at very high levels in the Hungarian tradition of music-making.

## The Influence of Liszt

In this section of the paper, I will attempt to show how an example from the Liszt repertoire, the *Deux Legendes*, exemplify some parts of the Hungarian piano school. As a founder of the Royal Academy of Music and the most influential musical figure of the Hungarian musical tradition, it is easy to trace his musical ideals to the Hungarian school that exists today.

The *Deux Legendes* are comprised of two programmatic pieces: *St. Francois d'Assise. La predication aux oiseaux* (St. Francis of Assisi. Sermon to the Birds) and *St. Francois de Paule merchant sur les flots* (St. Francis of Paul walking on the waves). They were written between 1860 and 1863 in Rome, Italy and are parts of the large religious repertoire composed by Liszt. As in many of his late works, these are both largely impressionistic – it has been said that Liszt was the first impressionist, many decades before Debussy emerged. They are characterized

by fine fingerwork passages, which have to be both clear and blurred in sound to create color and effects that evoke the subject matter. In *St. Francois d'Assise. La predication aux oiseaux*, the effect is the sound of chirping birds; in *St. Francois de Paule merchant sur les flots*, it is to create water and waves. Both are structured around thematic transformations that lay out the programs.

After brief analyses of thematic development and technical demands of the piece, I will emphasize the characteristics detailed that help to show how Liszt's musical ideas have influenced the way the piano is still approached in Hungary.

### *St. Francois d'Assise. La predication aux oiseaux*

*St. Francois d'Assise. La predication aux oiseaux* uses the development of two main themes, one representing the high-pitched, chirping birds and the other, in a lower register of the keyboard, representing the words of St. Francis of Assisi. The piece opens with the chatter of the birds. The bird motives are characterized by a perpetual *leggiere* trill, grace notes, and short, simple, phrases centered around the interval of a third. The voice of St. Francis tentatively steps in during a moment of silence from the birds in measure (m.) 52 with a single melodic line, played in the left hand. This melody is marked by a rhythmic motive of dotted notes and is centered on the interval of a fourth. These phrases are also short but show greater fluidity than those of the birds. From m.52 to m.71, the short phrases of St. Francis alternate persuasively with the grace

notes and trills of the birds. In m.72 to m.82, almost exactly halfway through, the motivic rhythm of St. Francis is used in a *maestoso assai* chorale, when his message can be delivered. Measure 82 transitions into the last half of the piece, which intergrates both the St. Francis thematic elements and the motivic elements of the birds. Returning to a higher register of the keyboard, the *leggiere* perpetual motion accompaniment returns with a melody derived from the St. Francis theme. From m.105, the trill returns to accompany a repetition of the melodies, and the piece begins to build to the final climax. It is followed by an immediate drop in intensity with a return to the chorale, closing with the separate themes alternating again before the birds fly off, and the different components of the bird theme fade away.

In this first Legend, the programmatic elements are clearly presented through the transformation of thematic materials. The technical demands, as in most works by Liszt, are great, though somewhat more subtle here. The 32<sup>nd</sup> notes in trills, arpeggios, and twisting chromatic passages, though *leggiere* and labeled pianissimo most of the time, must be clear, transparent, and light, requiring fine and very even fingerwork. The St. Francis theme and chorales require a warmer and firm sound. Throughout the piece, voicing in chords and phrases requires special attention. Perhaps, though, the greatest difficulty in this work is to create subtle changes in sounds and colors as the same, quiet motives move through different keys with only subtle differences for much of the ten minutes.

## St. Francois de Paule merchant sur les flots

The majority of the second legend is a chorale with a tremolo or scale passages underneath in imitation of the movement of the water, calm at times and increasingly stormy as the piece continues on. It uses only one theme, presented simply in the first two measures of the piece. This theme is then transformed through several major sections through very chromatic harmonic changes.

After its initial statement in the introduction, the theme is transformed into a chorale with a calm tremolo beneath, moving in intensity to the next section, beginning at m.33, with chromatic scales in the bass clef cresting in waves. The wave element continues to change into scalar and arpeggiated passages, passing through several keys, changing registers, and increasing gradually in dynamic level to m.65. From this point, the theme disappears and is overcome by an overall chromatic upwards movement, changing from thirds to chords to octaves and finally settling in m.92, where a triumphant theme returns, reiterated and grounded by a strong bass. In m.106, another strong upward movement begins with the theme again absent, cresting at times and beginning again. This continues to m.129, when the upward movement, dynamic intensity, and harmonic tension abruptly end. In the *lento* coda, Liszt uses a Schumann-esque technique, with a poetic and thoughtful recitative that closes the narrative, bringing back the theme in

reminiscence in its final appearance from m.129 to m.155 as it builds into the last heavenward reach that ends the legend.

As in the first Legend, *St. Francois de Paule merchant sur les flots* presents several technical difficulties, though more obvious. The tremolos, scalar and chromatic passages, chromatic thirds, octave runs and passages, arpeggios, and leaps on the keyboard are all major pianistic challenges. One of the greatest difficulties in this piece is to restrain from building the intensity too quickly; it is easy to become too loud too quickly, leaving no room for growth.

## Connections between Liszt and the Hungarian Piano School

Several aspects of the Hungarian school of teaching can be derived from the musical elements that Liszt presented in his works for piano. This paper will now attempt to show how the musical ideals derived from the brief thematic and technical analysis of the *Deux Legendes* helped to shape the Hungarian piano school.

While all music has some structure or framework to it, the architecture to these programmatic pieces, though not necessarily simple, is more easily observed than in others. By briefly outlining structure through exploration of thematic development, a clear idea of musical direction can be formed. This understanding and clear organization of musical structure is one essential part of

Hungarian pianism. Moreover, because the thematic changes may be small, performers must have sensitivity to the significance of such small variations. For instance, a single theme in *St. Francois de Paule merchant sur les flots* is repeated over for eight minutes, with each repetition leading to another statement but with greater intensity. In *St. Francois d'Assise. La predication aux oiseaux*, it may be difficult to keep the attention of the audience, as the majority is played in a high range of the keyboard, marked piano or softer, and based on only a few motivic elements, such as rhythm, intervallic restrictions, and fluidity of the melodic lines. A sensitivity to sound allows pianists to differentiate between sections. Though these changes may be small, in an overall performance, they can make a performance outstanding.

An additional note on thematic changes – one reason that the architecture of both pieces is clear is that every intention of Liszt is written in. Beyond directions for creating mood, such as *maestoso assai* (very majestic), every phrase is clearly marked; often, the way to play an individual note, or its articulation, is noted. The written instructions are clear, and keeping to the score will help the performer communicate what Liszt intended to be told with this religious set. This may reflect of his respect for the intentions and wishes of composers, which is an important part of learning stylistic correctness in the Hungarian musical training. With all details written in, though, it also becomes more obvious that the responsibility of musical sensitivity still lies with the performer, who is concerned with what

goes on between the notes, how to create the sounds he wishes to convey.

The technique required in both works of this set also reflects aspects of the Hungarian piano school. Both are virtuosic in some manner, requiring some technical brilliance, though in completely different ways. Inherent in the filigree work is the expectation of finger dexterity and lightness of touch. Neither piece calls for a hard or heavy sound; there should always be a clear, transparent touch, even in the louder, climactic sections.

## Conclusions

The Hungarian school of pianism can simply be viewed as another result of the Hungarian national character. The twentieth century was one of extreme hardship for the nation, and yet its people

held onto the national identity with fervor, and perseverance. Likewise, the piano school and musical ideals that Franz Liszt established at the end of his life in Budapest remained influential through two World Wars and decades of Communist rule. Yet the strict codes of communism in such competitive professions as music and sports also infiltrated into the Hungarian piano school, and this resulted in brilliant technique as well as a demanding training schedule starting at a very young age.

It is this intense training and strive for technical perfection combined with the refinement and musical sensibility of that elegant Golden Age and Franz Liszt that distinguishes the Hungarian-trained pianist from all the other musicians of the world. It is also this combination that has produced so many of the world's greatest and most respected musicians.

Fulbright

Grantees

2006-2007

# Atomic force microscopy and spectroscopy of synthetic myosin thick filaments

Brennan Decker

---

*St. Olaf College  
Northfield, MN  
www.stolaf.edu  
brennandecker@gmail.com*

*University of Pécs  
Faculty of Medicine  
7624 Pécs Hungary  
biofizika.aok.pte.hu/en  
Adviser: Dr. Miklós Kellermayer*

---

*New technologies allow scientists to observe biological molecules at an ever smaller and more detailed level. For example, the atomic force microscope, or AFM, can be used to visualize and manipulate single proteins. The protein myosin II changes its shape to cause muscle contraction. Myosin molecules have two ball-like heads attached to a long tail. In muscle, many myosin tails bind together to form a bipolar filament. We used the AFM to image, for the first time in aqueous conditions, synthetic myosin thick filaments, which revealed fine structural elements of the filaments. We measured the effect of polymerization conditions on the length, height and width of filaments. Force spectroscopy experiments yielded several notable conclusions concerning the internal forces that hold the thick filament together. Future work will focus on examining smaller units of the thick filament and the myosin molecule itself.*